The Engineer

LONDON, FRIDAY, JULY 25, 1941.

PUBLIC NOTICES

WEST CHESHIRE WATER BOARD

18in. TRUNK WATER MAIN

Tenders are Invited from general contractors for the EXECUTION of the necessary TRENCH EXCAVATION, REFILLING, SURFACE REINSTATEMENT, and DISPOSAL of SURPLUS SPOIL in connection with the Laying of an 18in. Cast Iron Trunk Water Main, for a distance of about 3 miles, the major portion of which will be along main roads with tar mac surface and contained within the Borough of Bebington and the Urban District of Ellesmere Port, situated in the Wirral area of the County of Chester.

Specification, form of Tender, &c., may be obtained from the undersigned, and application must be accompanied by a cheque for £2 2s., which will be refunded on receipt of a bona fide Tender and return of all documents, &c. (provided Tender is not afterwards withdrawn).

Sealed Tenders, endorsed "Excavation Work for 18in. Main," must be addressed to the Chairman and members of the West Cheshire Water Board, at the undernoted address, and delivered not later than Noon on Monday, the 18th August, 1941.

The Board do not bind themselves to accept the lowest or any Tender.

C. HARDMAN, A.M. Inst. C.E.,
Engineer to the Board.

Water Board Buildings,
Cross Street,
Birkenhead. 7643

CITY AND ROYAL BOROUGH OF DUNDEE

ASSISTANT TO STATION ENGINEER

Applications are Invited for the above APPOINTMENT from experienced Engineers of an age preferably not over 40, at a salary in accordance with the National Joint Board Schedule, Class H, Grade 6, at present £488 per annum. A 30,000-kW extension is nearing completion.

The appointment will be subject to the provisions of the Local Government Superannuation Act, 1937, and the selected candidate will be required to pass a medical examination.

Applicants must have a sound theoretical knowledge and considerable practical training and experience in the operation and maintenance of large modern high-pressure boilers, fuel and ash-handling plant, turbo-alternators and their associated auxiliaries. The successful candidate will be required to take charge of all overhauls and repairs, and must have the initiative and resource necessary for organising and expeditiously carrying out such work and for dealing promptly with emergencies, as well as boiler and turbo-alternator efficiency tests. A thorough knowledge of the principles of fuel combustion and steam generation is also essential, and he would also be expected to assist the generation engineer in any special matters relating to the running of the station.

Applications, stating age, full particulars of theoretical and mechanical training, experience and qualifications and accompanied by copies of recent testimonials, should be forwarded to the undersigned.

D. H. BISHOP, B.Sc., M.I.E.E.,
General Manager and Engineer.

Dudhope Crescent Road,
Dundee,
11th July, 1941. 7620

CITY OF SALFORD

APPOINTMENT OF DIRECTOR OF PUBLIC CLEANSING

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For conditions of appointment send stamped addressed envelope to
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SOUTH-EAST ESSEX TECHNICAL COLLEGE AND SCHOOL OF ART

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The man appointed will be required to take day and evening classes, and in particular classes on Internal Combustion Engines to Higher National Certificate standard.

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Forms of application, for which a stamped and addressed envelope should be sent, may be obtained from the Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham, and should be returned to him by the 6th August.

B. E. LAWRENCE,
7642 Chief Education Officer.

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

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The Engineer

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PAPER ECONOMY

It has now become necessary, in order to maintain the normal circulation of THE ENGINEER, to print all advertisement pages on the Thin Paper hitherto used for the Foreign Edition.

So long as our diminishing stocks of thick paper will allow, the Home Edition Editorial pages will be printed on the usual paper, so that uniformity in bound volumes may be maintained.

SITUATIONS OPEN

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

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The Engineer

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This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER each alternate month. Next date, August 29th.

ADVERTISEMENTS.

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Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

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A Seven-Day Journal

Organisation of Production

IN a Journal note of July 11th we referred to the appointment of a Central Joint Advisory Committee to the Production Executive and the extension of the Area Boards by the addition of representatives of important official organisations. In a statement issued by the Production Executive and given in the *Board of Trade Journal* the extended functions and duties of the Area Boards, which are to be renamed the Production Executive's Regional Boards, are defined as follows :—Maintenance of the Production Executive register of capacity for the region ; arranging interchange of machine tool capacity to relieve overload and to expedite production ; suggesting remedial action in regard to firms that may become overloaded with a multiplicity of contracts ; advising the Regional Controller of factory and storage accommodation on providing and allocating factory accommodation ; co-operating with the emergency repairs department of the Ministry of Works and Buildings ; maintaining liaison with the emergency service organisation through the Ministry of Aircraft Production ; bringing to the notice of the appropriate authority any transport difficulties, whether of workers or of goods, and securing their co-operation ; maintaining touch with the Board of Trade representative regarding concentration of industry ; bringing to attention raw materials difficulties ; explaining, through the trade unions, and employers' associations' representatives, the production difficulties which give rise to discontent ; and co-operating with the Ministry of Labour and National Service on difficulties of labour supply and training and in the application of the Essential Work Order. Capacity clearing centres are to be set up by the Regional Boards where necessary.

Retirement of Mr. J. S. Peck

IT is announced by the Metropolitan-Vickers Electrical Company, Ltd., that Mr. J. S. Peck, who for thirty-seven years has been chief electrical engineer of the company, has retired, while still retaining his seat on the board. Mr. Peck was born in New Haven, Connecticut, in 1871. He graduated from Cornell University in 1892 with the degree of M.E. (Mechanical Engineer) and entered on a "students'" course with the Westinghouse Company, Pittsburgh, in February, 1893. When the works moved to East Pittsburgh in 1895 with the late Mr. P. A. Lange as general works manager, Mr. Peck became chief engineer of the transformer department, and was also in charge of lightning arrestor department. He joined the British company in 1904. Mr. Peck was responsible in his capacity of chief electrical engineer for the electrical developments in the company's manufacture that have taken place over this long period. He became an associate member of the Institution of Electrical Engineers in 1905 and a full member in 1907. He was Chairman of the N.W. Section, then known as the Manchester Local Section, for the 1910–11 session and was very active in the affairs of the Institution. In January, 1928, he was elected to a seat on the board of the Metropolitan-Vickers Company. He will always be remembered by the employees of the company, more particularly those who worked directly under him, for his capacity for smoothing out difficulties and of getting everyone to give his best. He is succeeded in the position of chief electrical engineer by Mr. G. A. Juhlin, formerly the chief engineer of the plant department. Mr. G. A. Juhlin was born and educated in Sweden. In 1903 he joined the firm of Dick, Kerr and Co., of Preston, remaining with them till 1915. During the last eight years of that period he held the position of chief A.C. design engineer. He joined the Metropolitan-Vickers Company in 1915 and was appointed two years later chief engineer of the plant department, in which capacity he was responsible for the design of the firm's heavy electrical products. Mr. Juhlin has taken an active part in the Institution of Electrical Engineers, being Chairman of the N.W. Centre for the season 1923–24. He has contributed a number of papers to the Institution, chiefly on questions of design, and in 1929 he visited the Far East on behalf of the company.

Labour Problems in Filling Factories

THE Seventeenth Report from the Select Committee on National Expenditure, recently published by H.M. Stationery Office, deals with labour problems in filling factories. Its findings are summarised as follows :—Absenteeism in filling factories is due to causes which should be cured largely by administrative action, after which the residue of culpable absentees could be appropriately dealt with. The provision of adequate transport facilities for the workers should be regarded as a primary duty of the Ministry of Supply, either by special arrangements with the railway and omnibus companies or otherwise. The provision of an adequate number of hostels, as near as possible to the factories, should be speeded up as a matter of urgency, and the scale of charges should be reconsidered on the lines of rent for a room and payment for such meals as are actually taken. The canteens should be the subject of special and urgent consideration, especially the problem of cooking arrangements, the provision of adequate equipment and the prices charged. The supply of food should be given reasonable priority and the Ministry of Food should be approached on this question. Sunday work should be abolished, except for maintenance of plant or in real emergencies. Some adjustment of time rates is probably a necessary corollary to this step. Increase in production can be achieved by the removal of causes of legitimate grievances and by increasing incentive. Piecework should be introduced where appropriate. The conditions of work should be improved so as to reduce industrial fatigue. The appointment of men of first-class ability to manage Royal Ordnance factories is of the highest importance but the Ministry is handicapped by the scale of salaries laid down by the Treasury. This scale should be the subject of an urgent review.

Emergency Powers (Defence) Regulations

AN Order in Council, Statutory Rules and Orders, 1941, No. 1023, made by His Majesty the King on Friday, July 18th, provides supplementary provisions with regard to the Government control of undertakings. It provides for the removal and replacement of any person having functions of management, if it appears to the competent authority that he is acting or has acted in such a manner as to obstruct the authorised controller in the performance of his duties. The Order also gives authority for the acquisition of the company's shares and their transfer, with the consent of the Treasury, to nominees. Any person who may be removed from any office or position will not be allowed to hold another office in the undertaking unless by permission of the competent authority. It is also provided that a person appointed by the competent authority to hold any office shall not, unless it is otherwise agreed between him and the company, be entitled to receive any remuneration out of the moneys of the company in respect of that office or position. With further regard to the transfer of shares, holders of shares are under the liability of surrendering them to the transferees, who shall become exclusively entitled to all the rights and advantages of members of the company, notwithstanding that they are not entered in the register of members. No petition shall be presented for the winding up of the company nor any person rendered liable for the payment of its debts because the number of its members is below that required by law, while a director of the company may not resign merely because he has ceased to hold qualifying shares. The price to be paid by the competent authority in respect of any shares transferred by virtue of an order is laid down as that which, in the opinion of the Treasury, is not less than the value of those shares as between a willing buyer and a willing seller on the date of the Order. The Order also provides for the covering of accrued dividend rights, as well as the payment of outstanding charges. It contains a provision for an appeal to the arbitration of a qualified accountant, nominated by the Lord Chief Justice of England against any valuation of the company's shares made by the Treasury. Finally, the competent authority may make such modifications of the articles of association of a company as appears to the authority to be expedient, in consequence of the exercise of its powers.

Discipline in Armament Factories

A NEW Order made by the Minister of Labour and National Service, entitled the Essential Work (General Provisions) (Amending) Order, issued on July 19th, seeks to improve the discipline in those factories which are engaged on important Government contracts. Its proposals have been approved by the Joint Consultative Committee, which is made up of representatives of the employers and the trade unions. The principal Order, we may recall, allowed the employer to suspend a worker from his job, but entitled the worker to be paid his whole wages. In effect, this provision gave the worker suspended on disciplinary grounds a short holiday with pay. The new Order referred to above restores to the employer the right to suspend a man on disciplinary grounds without pay up to a limit of three days. It also contains a provision enabling the worker to appeal to the Local Appeal Board within three days of his suspension. Should the Board be unanimously of the opinion that the suspension was unjustified, or if the Board is not unanimous the National Service Officer is of the opinion that the suspension was unjustified, then he will not, because of the suspension, be disentitled to the guaranteed wage for the period of suspension. If the finding of the Board is against the worker, he will not be entitled to such a wage for the days of suspension, but if he is a time worker he will remain entitled to a proportionate minimum wage for the remainder of the week concerned. This additional safeguard has been included for time workers because the guaranteed wage of pieceworkers is calculated for the day. Other sections of the new Order refer to workers absent for part of the week due to sickness. With regard to offences against discipline, it is pointed out that the various special Essential Work Orders which were made later than the general Order have provided that employers may report to the National Service Officer cases of indiscipline as well as of absenteeism and lateness. The general Order only provided for cases of absenteeism or persistent lateness at work. Under the new amending Order employers may now report failure to comply with lawful and reasonable orders which include orders as to the working on day or night work, and a reasonable amount of overtime. Power is also given similar to that already possessed by the Essential Work (Building and Civil Engineering) Order to schedule an undertaking in respect of specified classes or descriptions of persons. It is the intention that in ordinary cases all the persons employed in an undertaking will be scheduled, but the power given will enable particular classes of persons to be excluded from the operation of the Order. The present provision requiring that every worker in a scheduled undertaking must be covered has been found too rigid in certain cases.

Britain's Tank Development

IN our issue of July 11th we described and illustrated the new "Valentine" infantry tank. During the past week the Ministry of Supply gave preliminary particulars of a new type of heavy infantry tank, which is being mass produced in British factories. It takes its name from the Prime Minister, who is one of the few civilians who has ridden the new type of tank, which is called the "Churchill." This tank, the Ministry says, is probably the most formidable fighting instrument possessed by any army in the world. It is heavily armoured to give the maximum protection to the crew, but is able to move over any kind of ground at a high speed. Its great gun power is concentrated in the minimum space. The Ministry of Supply states that it is unlikely that many enemy machines could stand up for long to the devastating fire of these new tanks. It adds that if for any reason the "Churchills" were brought to a standstill, the thickness of their armour would enable them to be used as small fortresses or strong points. Details of the new tank are, of course, closely guarded secrets, but it can be stated that the design embodies the ideas of tank officers who have had service in France, Libya, and Greece.

Merchant Shipbuilding in America

ELSEWHERE in to-day's issue we give some particulars of the two recently constructed shipyards at Richmond, California, at which ships for British and American mercantile services are being rapidly built. In our next issue we hope to deal with the Todd-Bath Iron Shipbuilding Corporation's yard at South Portland, Maine, where a further thirty cargo ships are being built to British account. At the end of last week Mr. Harry Hopkins, the supervisor of the American Lease and Lend programme, arrived in Great Britain in a bomber. Speaking at a Press conference on Friday afternoon, July 18th, Mr. Hopkins gave some interesting figures with regard to the great drive now in force in the United States of America for the assistance of the Allied mercantile fleets. He said that he did not think he was giving any secret away when he said that America would build at least 6,000,000 tons of new ships in 1942, and substantially more than that in the following year. Those ships would be ready for service in those years, and during the present year about 1,000,000 tons of new ships would, Mr. Hopkins stated, be completed and ready for service. All the ships, he continued, which America was going to build would go into the war effort, and would include tankers and merchant ships of all kinds. The figures he had given did not include warship construction. The figure of 6,000,000 tons he had referred to as being completed next year would be nearly 2,000,000 tons more than was built in United States shipyards during the peak period of the last war. The programme the American shipyards were undertaking was, he said, the biggest ever embarked upon by any country in history, and they were going to build enough ships to bring goods into the United Kingdom, and, indeed, into every theatre of the world where the democracies were fighting Hitler. All the Axis ships in America had been seized, and all United States owned ships were being directed to the war effort. That, he concluded, was being done in the closest co-operation with the British Ministry of War Transport, and its representatives in the United States of America. Iceland, Mr. Hopkins recalled, had been occupied, and it was legal for American merchant ships to go to that country.

Further Canadian Locomotive Experiences

By EDWARD H. LIVESAY

No. VII

(*Continued from page 379, June 13th*)

FOUR-COUPLED ENGINES ON SECONDARY SERVICES, C.P.R.

THE history of the four-coupled locomotive goes back to the very beginning of railways. The first engine to propel itself along rails, Trevithick's "tram locomotive" of 1803, was of this type; that gears instead of rods coupled the two axles does not affect the case. Throughout the century the type remained in extensive use; it still does a vast amount of work in Great Britain, and it will probably continue to do so for a long time yet. In America, however, it began to lose ground earlier than in the land of its birth. Trains became too heavy for it; six-coupled engines were called for to handle the continually increasing loads. Then came the booster, and the use of eight and even ten-coupled engines in passenger service; the four-coupled engine's day was apparently over.

A few years ago it seemed possible that the type might stage a limited revival in America for service on the light ultra-fast trains which were being introduced in an attempt to woo back to the railways traffic that had been lost to the roads. Some very striking four-coupled engines were built, with 7ft. wheels, such as those on the Baltimore and Ohio and Chicago N.W. railways. They might almost be regarded as a "throw-back" to the Vauclain compounds, four-coupled, big-wheeled, that did such wonderful work between Philadelphia and Atlantic City in the late 'nineties and early 1900s, often averaging between 60 and 70 m.p.h. start to stop with quite considerable loads, work unique and unapproached up to that time, and which to this day has been little improved upon. But they were rather special engines, built for exceptional and limited service; general-purpose types were preferred in America then and as a rule are still, so these four-coupled engines proved ephemeral and did nothing to halt the prevailing trend in the direction of six-coupled machines.

Recently the march of time called for the reintroduction of light, fast trains, and gave a fresh lease of life to this more or less moribund type, though it remains to be seen whether it is but a flash in the pan. In 1937 the C.P.R., affected in the same way as some American lines, and with similar ends in view, introduced locomotives of the 4–4–4 type, the "3000" class, with 80in. wheels, for handling light, fast, non-stop trains; they are illustrated by Fig. 24. Experience with these engines led to the building of somewhat similar engines, but with certain modifications, later in the same year, the "2900" class, Fig. 25. The wheel arrangement was unaltered, but the connecting-rods drove the second coupled axle, allowing a shorter boiler and wheel base; the driving wheels were reduced to 75in. The cylinder diameter was decreased 1in., leaving the tractive power unaffected, and the weight also was cut by several tons, but the engines were still capable of high speed with light trains. They are attractive machines and would undoubtedly have given a good account of themselves in the kind of service for which they were originally intended, but unfortunately to a great extent this failed to materialise, and the engines had to be diverted to other work, such as hauling stopping trains over secondary lines; trains which vary a good deal in weight. When the engines are overloaded, as sometimes happens, the limitations of the four-coupled design naturally show up, and the engines are criticised for their inability to achieve the impossible. The trains running over the Toronto-Montreal line, *viâ* Peterboro, are typical of these services, and illustrate the duties to which many of these engines have been allotted; one of these trains is dealt with in this article. A very condensed account came into article No. VI in THE ENGINEER of November 15th last; this is the full story.

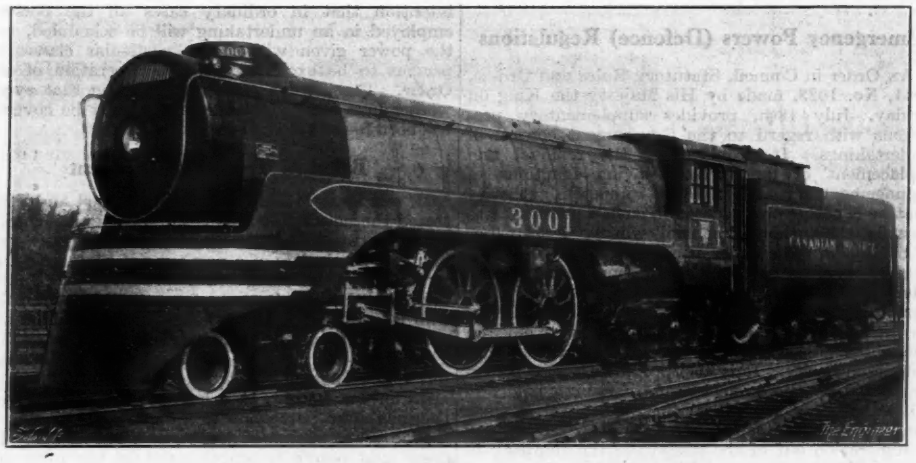


FIG. 24—C.P.R. "3000" CLASS 4-4-4 LOCOMOTIVE

The chief dimensions of the "2900" class are as follows:—

Cylinders	16½in. by 28in.
Driving wheels	6ft. 3in.
Boiler	67½in. and 73in. by 16ft.
Fire-box—Length	93in.
Width	70in.
Grate area	45 square feet
Pressure	300 lb.
Weight—Leading truck	23·6 tons
Drivers	49·6 ,,
Trailing truck	33·5 ,,
Total	106·7 ,,
Engine and tender	188·4 ,,
Heating surface—Tubes	2091 square feet
Arch tubes	31 ,,
Fire-box	169 ,,
Superheater	909 ,,
Total	3191 ,,
Wheel-base—Driving	7ft. 2in.
Engine	32ft. 7in.
Engine and tender	64ft. 9in.
Tractive effort	26,000 lb.
Factor of adhesion	4·28
Coal	12 tons
Water	7700 gallons

The boiler is domeless and has a multiple throttle and Schmidt superheater, Walschaerts valve gear and Wakefield lubricators are employed, with an "Elesco" feed water heater. They are hand fired.

It will be seen they are quite powerful engines, with considerable adhesion, despite the two-axle limitation, and that boiler power related to cylinder capacity is generous with the result that steaming is good. Semi-streamlining was a feature, and this originally extended to the chimney; it is now made 1ft. higher, as in the photograph.

A few words on the route. From Montreal to Toronto *viâ* Peterboro is 338·6 miles. To Glen Tay, 144 miles, it is part of the double-track main line, but from thence it is single; this section has not previously come into these articles, as has the major route *viâ* Belleville and Trenton. It acts as a relief line and is actually a couple of miles shorter than the other. It makes double tracking of the main line beyond Glen Tay unnecessary and has the additional advantage of serving another stretch of country.

"Train No. 35," with which this article deals, is a general-purpose train. It is the Canadian equivalent of the English services that came into the "Veteran Locomotives" article in the July 28th, 1939, THE ENGINEER, on the London, Three Bridges, Tunbridge Wells triangle. Carrying passengers, mail and express (parcels), it stops at every station, including some of the "flag" type ("halts" in England), and though its average speed naturally suffers, a maximum of 70 m.p.h. is sometimes reached between stations and acceleration must be rapid. On this occasion the train consisted of four cars, one a buffet parlour, weighing, say, 275 tons. Leaving Windsor Station, Montreal, at 9.25 a.m., in pouring rain, with engine "No. 2925," and Engineer Drew and Fireman Fitchell in the cab, I found that though the latter was of the usual comfortable enclosed type so well suited to the Canadian climate, it was not provided with a third seat—until later on the conductor (guard) took pity on me, and produced a block of wood as a substitute. The start was watched with interest; it was a four-coupled engine, the load was appreciable, and the rails were wet, so I was prepared for possible "cutting-up." Many enginemen, used to six or more coupled wheels, are apt to be impatient with the more sensitive class, often failing to give the throttle the gentler touch called for, but Drew was not of this type. He coaxed rather than forced "No. 2025," and was always ready with an instantaneous check if the engine showed the least sign of kicking up her heels. Sand was used, of course—both pairs of wheels get this—and there was no slipping; my notes say: "On full throttle and valve travel, almost at once cut to 45 per cent., then 25 per cent. when really moving." I had not expected such generosity. Incidentally, there is no booster on this class, though to my no doubt superficial way of thinking it is just the type of engine on which the booster would show its worth, and just the sort of train, too. But Mr. Bowen, the C.M.E., said "No," and I humbly defer to his dictum—but I still don't quite see why not! Perhaps for financial, other than mechanical, reasons? The safety valves were lifting as "No. 2925" pulled out, and the noise seemed greater than usual, possibly due to the high pressure, 300 lb. Fitchett agreed and added that when he "popped" too, the combined racket was awesome—this I could well believe. Generally the feed pump was put on to check blowing off; if already on, the injector. But it is impossible always to prevent blowing off on a stopping train, boiler demand fluctuating so frequently.

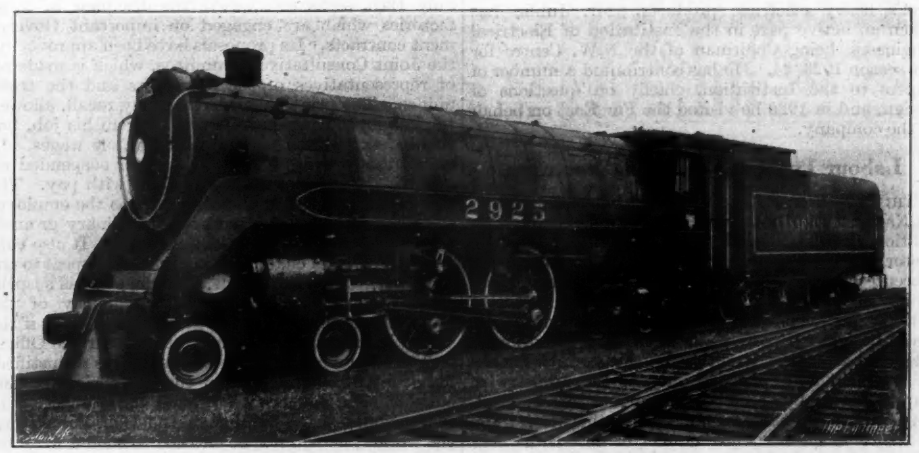


FIG. 25—C.P.R. "2900" CLASS 4-4-4 LOCOMOTIVE

In the 4·7 miles to Montreal West there were two stops; afterwards the speed rose to 60 m.p.h. and remained at about this figure most of the way to St. Annes, 20 miles. Sand was always used at starting; there had been no slipping so far, in spite of wet rails. Fitchett was kept very busy feeding the 45 square foot grate with what looked to me rather poor coal, fine and dusty. The fire-door was always kept closed between times, as seems to be the rule in America, unless it is opened as an additional check on blowing off. This brings me to the pneumatic treadle-operated door, already referred to several times in these articles, and with approval. Fig. 26 shows it and its operating gear. The fireman, having filled his scoop, turns toward the door, bringing his left foot on to the treadle A; its depression opens the valve B, letting air into the cylinder C, which in turn opens the divided door D. The two halves being hinged at the top, they swing apart, and in goes the scoop. Turning back to the bunker, the foot naturally leaves the treadle, and the door shuts. If the fireman wants the door to stay open the hand lever E is used, held by a catch. If necessary, this lever can be set to prevent the door shutting completely when the treadle is freed. This pneumatic arrangement is simple and effective, and I often thought of it during my English experiences, when watching firemen handling the more primitive devices sometimes to be seen there. One journey in particular comes to my recollection; a very long non-stop one, on a fine engine with none too generous boiler power, and a very skilful, almost pedantically conscientious fireman, who opened and closed the fire-door—by means of a chain—after every single scoopful, never once failing to complete the cycle. There was an inspector on the footplate, to say nothing of an observer, which may have had something to do with his scrupulosity; it would have had I been the fireman, I know! Thousands of times that chain was caught and pulled—in scoop—caught and pulled again. It really got on my nerves; I felt like bursting into tears. My admiration of his devotion to an exasperating duty was unstinted, but my detestation of the chain was absolute. The skill and work involved—the antiquated nature of the arrangement—its primitive inefficiency! So admirably suited to "Locomotion No. 1"—so completely out of place on a twentieth-century engine. I am fond of a fine locomotive, and it saddens me to see it associated with such a slipshod blemish. A chain-operated fire-door goes beyond being a blemish—it is almost a crime! But here again, finance may enter into the matter; a pneumatic fire-door costs more than a chain. It may be said apologetically of the latter what Monsieur Levassor said of the Panhard change-speed gear, and its clashing wheels: "C'est brusque et brutal, mais il marche." So is and does this infernal chain—but the ashcan is the proper place for it, nevertheless.

After St. Annes came Vaudreuil; thence it was uphill to St. Lazare, taken easily at 40 m.p.h. "No. 2925" was steaming very freely, and there was considerable blowing off, due to the ample boiler and frequent stops. There is no stinting of anything connected with steam generation on these engines. Heating surface 3191 square feet, a 45 square foot grate, and 300 lb. pressure, yet the cylinders are only 16½in. It is a fault very much on the right side, if fault it be—and it is not. De Beaujeu, 44 miles, was reached at 10.29, after seven stops had been made since leaving Montreal, giving an average speed of 36 m.p.h., which is very creditable. Here one car was dropped, reducing the load to about 200 tons. A few miles farther on the Quebec-Ontario border was crossed, station names ceasing to be Gallic, and becoming Gaelic. After Glen Norman came Glenroy, 57 miles, a "flag stop," and I noticed the first slight slipping, the result of a very snappy start, the succeeding six miles to Apple Hill taking nine minutes, corresponding to the usual rate of travel.

Riding was good, a little rolling being the chief thing noticeable, probably due to track inequality; the frost was still by no means out of the road bed. In Canada it goes very deeply into the ground during the long, severe winter; only the surface had thawed out, and it was soft and waterlogged. The four-wheeled rear truck, as found on "No. 2925," does much to steady the running over rough track, though that is not its chief *raison d'être*, but the weight of the fire-box. A load of over 30 tons would be too great for one axle. The truck frame is anchored to a cross stretcher, Bissell fashion, as is always the case in America; it is double, the laminated springs lying between the side members.

At Chesterville, 87 miles, water was taken; the time was 11.49, and the distance had been covered in 144 minutes, inclusive of sixteen stops, making the average 36 m.p.h. Sixty was often reached between times; get-away was always quick, and certainly I could see nothing at all to complain of in this type of engine—except the absence of window wipers! The engine just demanded a little more consideration than a six-coupled one, and this it got from Drew.

A visit to the buffet car enabled me to look over the coaches, of which there were now only three. It was the last vehicle, a twelve-wheeler of an older type, very similar in design to that in Fig. 27. Though bringing up the rear, its motion was very steady, with little sway, despite short rails—about 40ft., I think, and staggered joints. Wooden construction was the rule in the past, and tare was not very great, but the introduction of steel, and then all-steel and air conditioning, ran it up, until an 85ft. diner of 1930 weighed 87 English tons. The heaviest vehicle of which I have details is Sir E. W. Beatty's private car, weighing 90 tons. The modern car, of alloy steel, is considerably lighter, and Fig. 28 is a good example of it. It is air conditioned, 65ft. long, seats seventy-two passengers, and weighs only 50 English tons. It is impossible to mix such cars as this with the old heavy stuff, however; it must be used in trains made up entirely of light cars. Little attempt was made formerly to reduce weight, and such features as triple windows, six-wheeled trucks, &c., ran the tare up heavily, but the day of the Leviathan is over. The transition stage brings difficulties, such as the mixing of light and heavy stock, imposing strains on draught and buffing gear, and still worse, trouble in the event of collision. "All or none" is the ideal; like most ideals, it is slow of attainment. From this it will be understood how the addition of one heavy car to a train may upset a four-coupled engine, and give the crew occasion to blaspheme; it is not a matter of a mere 35 tons, as in England, but might be over double that amount.

The Rosedale restart coincided with a heavy up gradient, and there was slight slipping, as the rain at Montreal had tapered off into a misty drizzle, just the thing to upset adhesion. The next stop was at Smith's Falls, the first divisional point, 129 miles, at 12.59, one minute ahead of time. The run had taken 244 minutes, including twenty-four stops, speed 32 m.p.h. Drew and Fitchett gave place to Boylan and Seabrook, and the usual servicing was done. Drew's handling of the engine had been a real pleasure to watch, as it was just the kind of thing a four-coupled engine responds to.

Smith's Falls was left at 1.10 p.m., and fast running followed over the 11·6 miles to Perth, covered in thirteen minutes, 53·5 m.p.h. The engine danced a good deal along here; the track was rough, and Boylan apologised. We branched

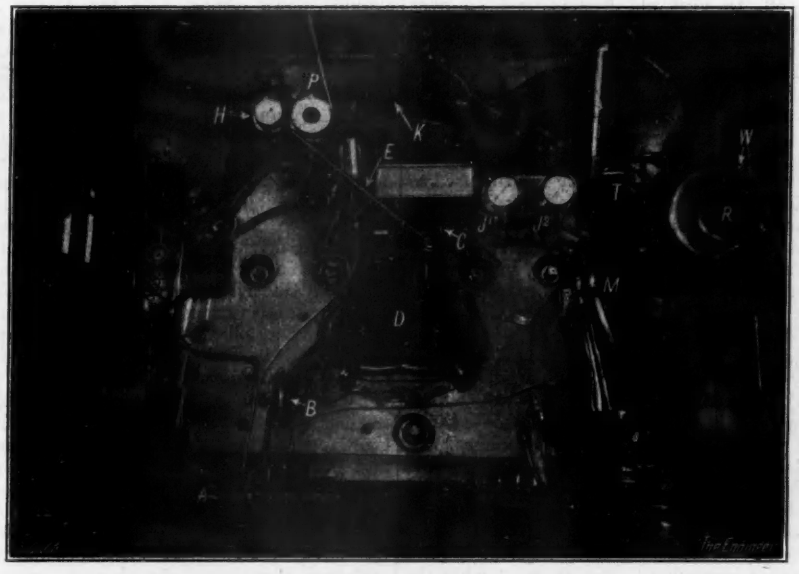


FIG. 26—CAB FITTINGS AND CONTROLS "2900" CLASS C.P.R.

FIG. 27—OLD TYPE WOOD CONSTRUCTION COACH

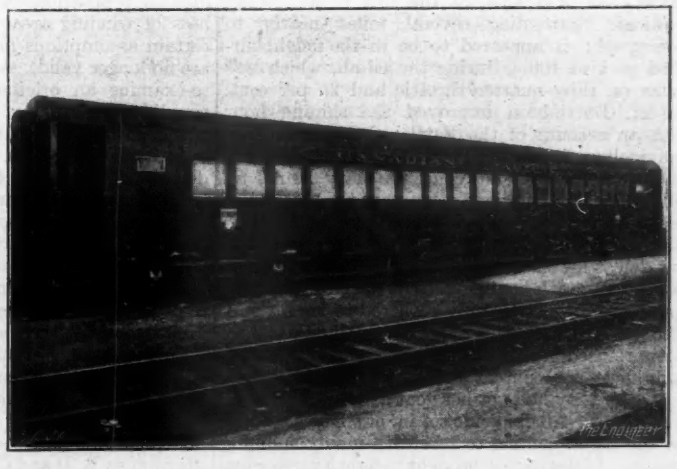


FIG. 28—NEW TYPE LIGHT ALL-STEEL COACH

off the main line at Glen Tay, entering the single-track route to Peterboro, and curvature and sharp gradients became more frequent, but the engine took them all well. Steam blew down a good deal, in spite of the higher chimney that had been put on since I had ridden the same engine two years earlier. "Blinkers" would probably solve this problem. The cool, misty air intensified the trouble; though it was mid-April, patches of snow still lay beside the track, and Lake Soko showed an expanse of grey, sodden ice. The countryside was drab and colourless; a dove let out from our mechanical ark would have returned without a green leaf or blade of grass. Shortly after leaving Sharbot Lake, however, the sun burst out, and things became more cheerful. Following Tweed a heavy ruling gradient was mounted, with the engine blowing off vigorously. A good steamer, evidently, but the fireman had no very easy job, what with the fine, dusty coal and 45 square foot grate. I did not feel inclined to use his seat at all, as he needed it far more than I did. But at Ivanhoe the conductor (guard) appeared with a block of wood, on which I parked myself at intervals, assuming a lowly position near the floor. It was not quite a seat of the mighty and reminded me somewhat of the stools of repentance, on which I have perched in England; still, it was far better than nothing. Along here Boylan thrilled me with a dramatic and gruesome yarn of a fireman who pitched head foremost into the fire-box; needless to say, he was cremated. Sitting on my block of wood, I contemplated the fire-door, fascinated. Could it really have happened, or was Boylan pulling my leg? *That* could happen, I know—it has actually in my experience. I will let the reader form his own conclusion, after looking closely at Fig. 26. May I draw his attention to some of the fittings on the back plate? T is the hanging throttle, held by catch and ratchet; R the reverse wheel, with the whistle trigger W just over it. M is the brake control gear, with the brake gauges J1 and J2 above. K is the steam turret; if it were outside the cab there would perhaps be less heat inside. H is the feed water gauge and P steam pressure ditto. It is a neat and well-arranged cab, the planished steel finishing and electric lighting adding to its attractiveness. The trigger for the air-operated whistle is very conveniently placed; the latter is sounded incessantly, at crossings &c.—and nearly always when one is in the middle of an interesting conversation.

Havelock, the second divisional station, was left at 4.11 p.m., two minutes early. The 109 miles from Smith's Falls had taken 181 minutes, including thirteen stops, 36 m.p.h. overall. Again the crew changed, Engineer Durrington taking over, and the train pulled out at 4.20 p.m. Over this last division I had noticed one or two instances of tricky starting, backing up being necessary before going ahead. The next station was Norwood—what a familiar sound the name has!—a well-remembered little town, my first place of abode in Canada. Many times in the old days had I walked along the track to town; nothing seemed to have changed very much, and the fields and woods alongside, in which I had toiled under summer sun, and in winter's frigid zero, looked very friendly and pleasant. And so through Indian River into Peterboro, a flourishing city on the banks of the beautiful Otonabee River, the only considerable urban centre on this route between Montreal and Toronto. It is quite a manufacturing place, where "Quaker Oats" come from, among other things. Here there was a fifteen-minute stop, and considerable station work; we left again at 5.15 p.m., for Cavan, the next halt, at the foot of a "ruling gradient" extending several miles nearly to Pontypool; it appeared to be in the neighbourhood of 1 in 100. During the climb, which was taken on three-quarter throttle and 25 per cent. cut-off, Durrington improved the shining hour with an account of the Battle of Cavan Hill, as the incline is called; the story is one of the division's classics. It concerns Mary Anne, an old dame who lived in a cabin near the track, and her cow, and tells how they fought an engagement with the C.P.R., ending in victory for Mary Anne, but defeat for the cow. It seems that one unlucky day, Bossy, with bovine vacuity, disputed a train's right-of-way and was duly gathered to her fathers. The C.P.R. ungallantly disclaimed liability, and flatly refused compensation. It was adding insult to injury—not content with getting Mary Anne's cow, now they had got her goat as well, and battle was joined. An epidemic set in, of engines stalling on the bank, coming to rest with madly spinning wheels. Investigation brought to light a mysterious substance on the rails—it looked like soap—by heck, it *was* soap! "Elementary, my dear Watson." But in spite of close watch and many sudden raids, Mary Anne could never be actually caught at her slippery tricks; trains went on stalling; Mary Anne went on soaping. Finally, admitting both defeat and liability, the company offered compensation; the epidemic ceased, engines found foothold, and peace once more descended on Cavan Hill. Thereafter Mary Anne's soap was used only on dirty linen, never on the rails. She had triumphed, and Bossy was avenged.

The fireman had no time to day-dream on Cavan Hill; the 45 square foot grate and poorish coal kept him fully employed, inducing a little peevishness, and doubts—passed *sotto voce* to me—as to whether the throttle and V.T. positions were the best possible for this particular gradient. It is unwise to take sides in the cab, so I shuffled out of the dispute, merely saying that in England some enginemen might use full throttle and a shorter cut-off, which might have been better from his point of view. The discussion was terminated by our arrival at Pontypool, 5.50 p.m., where I was stopping off, to visit old friends, and go over masses of notes that were piling up on me, the result of a couple of thousand miles' travel on all sorts and conditions of locomotives since landing. I was suffering from a surfeit of locomotives, and craved rest and recreation, to say nothing of relief from black-out.

During this rest cure I walked daily along the track into the village—the railway is often used as an unofficial thoroughfare in Canada—which gave me a chance to investigate the sort of road bed and steel that I had been running over. I was a little dubious about several things, and approached a section man (platelayer), asking him to expound unto me the scriptures. He said it was still too early to do serious work on the track, as the frost had not all come out of the ground. It does this unevenly; one tie (sleeper) may sink, and an adjacent one remain *in situ*, in which case "shims"—this was not his word, but it will serve—are put between tie and rail base, pending packing with ballast later, and proper levelling. The rails are spiked down and many of the spikes had worked up, not being in contact with the rail base at all. It did not look very good to me; had I known of this, the enjoyment of some of my trips might have been reduced somewhat! But there—"what the eye does not see, the heart does not grieve for," and things could not have been too bad, as all the engines on which I had ridden had remained on the metals. The Canadian winter is so long and severe that most track work has to wait for spring. I had just caught the Pontypool section in the transition stage, when defects could be seen, but it was not possible to do much about them. The sun was baking down and the rails were shimmering as I walked the track to Pontypool, yet a few inches below the surface the ground was as hard as iron and patches of snow still lay in sheltered places on May 1st. This was Ontario, of course, and a very late spring. By contrast, at the moment of writing, here in Victoria, B.C., February 15th, everything is in bud, and a Japanese plum tree is in full blossom; there has been no winter at all. But then, as everyone knows, Victoria is the Garden of Eden!

Ultimately carrying on with the same train and engine, the last stage to Toronto calls for little comment. Gradients over the Peterboro route are severe in places, and so sudden that one can see them coming, switchback-like. My thoughts went back to the Oxted to Tunbridge Wells route, on which I noticed the same thing, and my heart went out to it, and the sturdy little tank engines I rode, and am so fond of. Curvature along this Canadian line is also frequent, but "No. 2925" took it well, the short rigid wheel base and trucks at both ends being admirably suited to a sinuous track. From Donlands a long and severe gradient extends down almost into the Union Station, Toronto, where the train came to a stand at 7.25 p.m., O.T. The 338·6 miles had been covered in ten hours, including approximately fifty stops, two of them occupying twenty-five minutes. The overall average speed was therefore 34 m.p.h.—decidedly good, all things considered. One hundred and ninety-five miles were single track, and the stops averaged only about 6 miles apart. I liked the engine very much, and though for this sort of work nothing can quite offset the absence of another driving axle—except a booster, which, Mr. Bowen says, it does not need—to me it seemed a most attractive engine, and it was unfortunate that my observations were made when it was doing work which did not bring out its capabilities fully, and which was not the sort of thing for which it was originally intended.

I can guess what some critics will say after reading this account. "An engine with 26,000 lb. tractive effort, ample boiler power, 6ft. 3in. wheels and 49 tons for adhesion, handling a train weighing only 200–275 tons—why, she ought to eat it!" Granted, and so she did—this particular train. The point is she might have had to handle a much heavier one, under bad weather conditions, and still keep time over a heavy route, with stations only 6 miles apart, in charge of an engineer who was not fond of a four-coupled engine, and would not bother to humour it—then things would tell against it. A sort of "mixed traffic" design would be more popular and less likely to be overloaded. I am inclined to think the day of the four-coupled engine in Canada is over; "'Tis true 'tis pity, and pity 'tis 'tis true."

Reactance of Transformers with Sandwich Type Windings

By S. H. HEMSLEY, B.Sc.

WHEN the standard formula normally used for calculating the reactance of core type transformers with concentric windings is applied directly to similar transformers having sandwich windings—with the axial and radial dimensions interchanged—the calculated values seldom agree with the test figures. With sandwich type windings the proportions of height to total radial thickness of winding are of a different order, and so certain assumptions made in the original formula are no longer valid. Accordingly it is necessary to re-examine an original formula to decide what simplification, if any, can be applied under the new conditions without loss of accuracy.

In a classical work on the subject, Rogowski[1] derived a formula for the reactance of a core type transformer with symmetrical sandwich windings, and the following is based on this analysis, modified where necessary to bring it in line with one convenient form of standard formula normally applied to concentric windings. Other references of interest to the present study are given in the bibliography at the end [2, 3, 4].

In Fig. 1 the section of a symmetrical sandwich winding of a core type transformer, arranged with half a coil next to the top and bottom yokes, is shown. This winding consists of two primary and one plus two half secondary coils shown in the diagram as B, D and C, A and E respectively. The word "coil" is here understood to mean a group of one or more coils, which may be either disc or crossover coils, the term "group" being avoided because of the special meaning attached to it below. It is assumed that the ampere turns of the half coil A balance the corresponding ampere turns of the upper half of coil B; that the ampere turns of the lower half of coil B balance those of the upper half of coil C, and so on. In this particular example the winding is thus divided into four "groups" ($n=4$), the number of groups being equal to the number of radial air gaps, or twice the number of complete primary coils.

Coil B having a total axial dimension of $2\,a_1$ cm. is usually split up into two separate even-numbered groups of coils, axial dimensions a'_1 and a'_1, with a duct δ' between, so that $2\,a_1=2\,a'_1+\delta'$. Since δ' is always relatively small, it can be assumed without any appreciable error that $2\,a'_1=2\,a_1$. When coil B consists simply of a single crossover coil, $2\,a_1$ will be the total axial dimension of the coil. Similar assumptions refer to whole coils C, D, &c.

The reactance of the transformer, assuming a 1 : 1 ratio, is given by

$$X=4\,\pi\,w^2\,n\left(\delta+\frac{a_1+a_2}{3}\right)\frac{L_m}{h}\times K_1\times 10^{-9}\text{ henries,}$$

or

$$X=4\,\pi\,\omega\,w^2\,n\left(\delta+\frac{a_1+a_2}{3}\right)\frac{L_m}{h}\times K_1\times 10^{-9}\text{ ohms} \quad \ldots\ldots (1)$$

where

w=number of turns per group, primary or secondary,
n=number of groups, primary or secondary,
$\omega = 2\pi \times$ frequency (f),
a_1=axial dimension of primary group in centimetres,
a_2=axial dimension of secondary group in centimetres,
c=radial distance windings to core in centimetres,
h=radial height of windings in centimetres,
δ=radial duct primary to secondary winding in centimetres,
L_m=length of mean turn of windings in centimetres,
μ=permeability of the core,

$$k = \frac{\pi}{a_1 + a_2 + \delta}$$

$$K_1 = 1 - \frac{1 - \epsilon^{-kh}}{kh}\left\{1 - \frac{1}{2}\cdot\frac{\mu - 1}{\mu + 1}\cdot\epsilon^{-2kc}\left(1 - \epsilon^{-kh}\right)\right\}$$

and is a correction factor which takes account of the form of the leakage field as modified by varying proportions of the height to total thickness of the windings.

If the number of turns in each group is not the same—which is usually the case both with disc coils and crossover coils—the value of $w^2 n$ becomes $\Sigma w_1^2 n_1$. This will be made clear when actual examples are worked out later for comparison with test results. In further evaluations of formula (1) the original value $w^2 n$ will, however, be retained.

Formula (1) may be expanded further as follows:

$$X = 8\pi^2 w^2 n f \left(\delta + \frac{a_1 + a_2}{3}\right)\frac{L_m}{h} \times K_1 \times 10^{-9} \text{ ohms}$$

$$= 7{\cdot}9\, w^2 n f \left(\delta + \frac{a_1 + a_2}{3}\right)\frac{L_m}{h} \times K_1 \times 10^{-6} \text{ ohms}$$

If for f, $50 \times \frac{f}{50}$ is substituted, one slide rule operation is saved for all normal calculations.

$$X = 3{\cdot}95\, w^2 n \left(\delta + \frac{a_1 + a_2}{3}\right)\frac{L_m}{h} \times \frac{f}{50} \times K_1 \times 10^{-6} \text{ ohms} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This gives the reactance of a sandwich type winding when account is taken of the distance of the inside of the windings from the core.

If the transformer has not a 1 : 1 ratio, then the value of reactance will be referred to the primary or secondary side according as the values of w and n refer to the primary or secondary windings respectively.

Formula (2), expressed as a percentage of the voltage, is:

$$X = 3{\cdot}95\left(\delta + \frac{a_1 + a_2}{3}\right)\frac{L_m}{h} \times \frac{I\, w\, n}{v} \times \frac{f}{50} \times K_1 \times 10^{-4} \text{ per cent.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where v=volts per turn and I=current in the winding.

These formulæ have a maximum accuracy when

(i) $\frac{a_1 + a_2 + \delta}{a_1 + a_2}$ is approximately=1, or when its value lies between 1 and 2;

(ii) $kh = \frac{\pi h}{a_1 + a_2 + \delta} > 1{\cdot}5$, *i.e.*, when the radial height h of the windings is equal to, or greater than, the total thickness t of one group.

The first simplification that can be made to the somewhat complicated form of K_1 is to take $\frac{\mu - 1}{\mu + 1} = 1$, which is very nearly true for all normal values of induction used in the core.

$$\therefore \quad K_1 = 1 - \frac{1 - \epsilon^{-kh}}{kh}\left\{1 - \frac{\epsilon^{-2kc}}{2}\left(1 - \epsilon^{-kh}\right)\right\}$$

If we put $t = a_1 + a_2 + \delta$,

$$K_1 = 1 - \frac{1 - \epsilon^{-\pi \cdot \frac{h}{t}}}{\pi \cdot \frac{h}{t}}\left\{1 - \frac{\epsilon^{-2\pi \cdot \frac{c}{t}}}{2}\left(1 - \epsilon^{-\pi \cdot \frac{h}{t}}\right)\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Values of K_1 are plotted against $\frac{h}{t}$ for various normal values of $\frac{c}{t}$ in Fig. 2, in curve I for $\frac{c}{t} = 0{\cdot}05$, in curve II for $\frac{c}{t} = 0{\cdot}1$, in curve III for $\frac{c}{t} = 0{\cdot}2$, and in curve IV for $\frac{c}{t} = 0{\cdot}3$. The upper curves refer to values of K_1 between 0·6 and 1·0, and the lower curves to values of K_1 from 0 to 0·8, with the $\frac{h}{t}$ values drawn on a much larger scale. Usually, for the normal type of sandwich winding met with in practice, the lower curves will be more frequently used.

If in formula (4) for K_1, $c = \infty$, $\frac{1}{2}\epsilon^{-2\pi \cdot \frac{c}{t}} = 0$ and K_1, which we shall now call K, becomes

$$K_1 = K = 1 - \frac{1 - \epsilon^{-\pi \cdot \frac{h}{t}}}{\pi \cdot \frac{h}{t}} \quad . \quad . \quad . \quad (5)$$

This value of K_1, substituted in formula (2), will give the reactance of a sandwich type winding when the effect of the proximity of the iron in the core is considered to be negligible. Formula (2) then becomes

$$X = 3{\cdot}95\, w^2 n \left(\delta + \frac{a_1 + a_2}{3}\right)\frac{L_m}{h} \times \frac{f}{50} \times K \times 10^{-6} \text{ ohms} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

In Fig. 3 values of K are plotted against values of $\frac{h}{t}$, the lower curve again showing values of $\frac{h}{t}$ on a larger scale. It is interesting to note, in evaluating K, that with $\frac{h}{t} \geqq 1{\cdot}8$

$$K \approx 1 - \frac{0{\cdot}318}{h/t},$$

since $\epsilon^{-\pi \cdot \frac{h}{t}}$ is negligible to slide rule accuracy within these limits.

The influence of the iron in the top and bottom yokes on the reactance is very small. If it is assumed that the length of yoke covering the coils is on the average one-third of the mean circumference of the coils, and $2n$ is the number of full H.V. or L.V. coils per limb, then the maximum correction due to this is $\div \frac{17}{2n}$. For ordinary purposes this correction is less than the order of accuracy that can be expected in the original formula, and so can be neglected.

If in formula (5) we assume that $\frac{h}{t}$ is large—that is, that the length of the winding is great in comparison with the total radial thickness—we have the condition obtaining with normal concentric windings. Therefore K=1 and formula (6) becomes

$$X = 3{\cdot}95\, w^2 n \left(\delta + \frac{a_1 + a_2}{3}\right)\frac{L_m}{h} \times \frac{f}{50} \times 10^{-6} \text{ ohms,}$$

which is the standard formula for concentric windings. Expressed as a percentage this is

$$X = 3{\cdot}95 \left(\delta + \frac{a_1 + a_2}{3}\right)\frac{L_m}{h} \times \frac{I\, w\, n}{v} \times \frac{f}{50} \times 10^{-4} \text{ per cent.}$$

It now becomes necessary to decide from test results whether formula (2) or formula (6) can be applied in calculating the reactance of sandwich type windings.

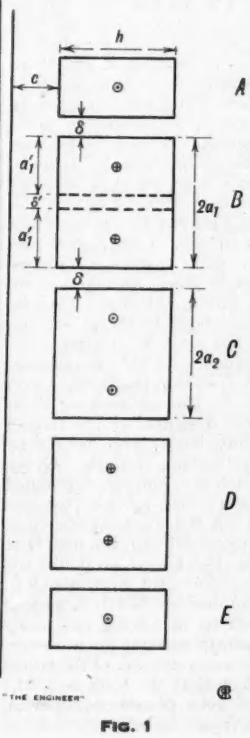
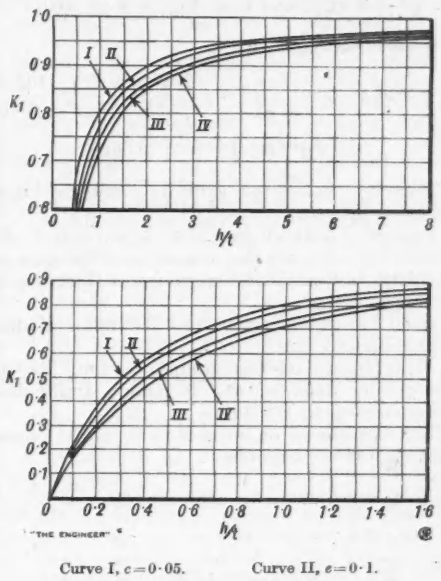


FIG. 1

The following test results have been obtained, as a matter of convenience, on medium to large-sized interconnected-star earthing transformers designed for operation on 6·6 and 11-kV lines. The transformers were of the core type and all had disc windings. The proportions of the tank and the values of reactance were such that no appreciable leakage flux passed through the tank sides; that is, there was very little difference between the tested impedance with the transformer in the tank and out of the tank. The results refer to the transformer tested out of the tank.

Normally, the value of impedance of an earthing transformer is of very little importance, since the magnitude of the fault current flowing is determined almost entirely by the ohmic resistance of the earthing resistance connected between the neutral and earth. Cases arise, however, where the windings of the earthing transformer are required to withstand the full fault current for a given time with the earthing resistance short-circuited, as when flash-over occurs on the neutral terminal of the transformer. Under these conditions it is desirable to be able to calculate the effective impedance with reasonable accuracy.



Curve I, $c = 0{\cdot}05$. Curve II, $c = 0{\cdot}1$.
Curve III, $c = 0{\cdot}2$. Curve IV, $c = 0{\cdot}3$.

FIG. 2

Example 1.—6·6-kV line, 1310 A in neutral, 50 cycles, 12-group winding, consisting of four groups of twenty-four turns and eight groups of twenty-six turns per group.

Axial dimension per group=21·4 mm. Radial dimension=43 mm.

Axial distance between groups=12 mm. Radial distance windings to core=26·5 mm. Inside diameter of windings=264 mm.

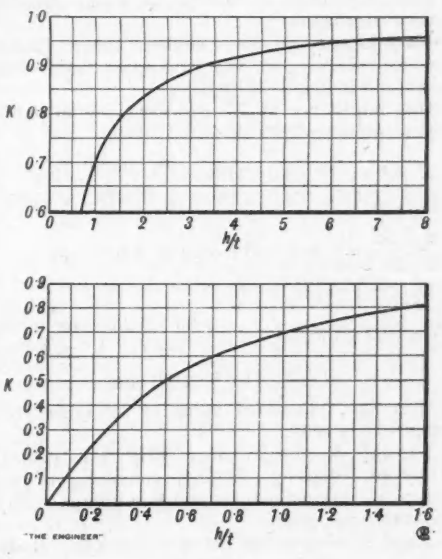


FIG. 3

Test impedance at 95 deg. Cent.=1·26 ohms. Test reactance=1·12 ohms.

$$\Sigma w_1^2 n = 4 \times 24^2 + 8 \times 26^2 = 7710. \quad \frac{a_1 + a_2 + \delta}{a_1 + a_2} = 1{\cdot}28. \quad kh = 2{\cdot}47.$$

$\frac{h}{t} = \frac{43}{54 \cdot 8} = 0{\cdot}785$, and from Fig. 3 K=0·628.

Applying formula (6),

$$X = 3{\cdot}95(7710) \times \left(1{\cdot}2 + \frac{2{\cdot}14 + 2{\cdot}14}{3}\right) \times \frac{96{\cdot}2}{4{\cdot}3} \times \frac{50}{50} \times 0{\cdot}628 \times 10^{-6} = 1{\cdot}12 \text{ ohms.}$$

Therefore calculated value of reactance=test value ±0 per cent.

Example 2.—11-kV line. 1575 A in neutral, 50 cycles, 16-group winding, consisting of sixteen groups of thirty-two turns per group.

Axial dimension per group=21·7 mm. Radial dimension=60 mm.

Axial distance between groups=15 mm. Radial distance windings to core=27·5 mm. Inside diameter of windings=266 mm.

Test impedance at 75 deg. Cent.=2·35 ohms. Test reactance=2·22 ohms.

$$\Sigma w_1^2 n = 16\times 32^2 = 16{,}380. \quad \frac{a_1+a_2+\delta}{a_1+a_2} = 1\cdot 28.$$

$k\,h = 3\cdot 23$.

$$\frac{h}{t} = \frac{60}{58\cdot 4} = 1\cdot 027,$$ and from Fig. 3 K=0·702.

Applying formula (6),

$$X = 3\cdot 95\,(16{,}380)\times\left(1\cdot 5+\frac{2\cdot 17+2\cdot 17}{3}\right)\times\frac{102\cdot 5}{6\cdot 0}$$
$$\times\frac{50}{50}\times 0\cdot 702\times 10^{-6} = 2\cdot 29 \text{ ohms.}$$

Therefore, calculated value of reactance=test value—3 per cent.

Example 3.—11-kV line. 790 A in neutral. 50 cycles. 14-group winding, consisting of four groups of thirty-six turns and ten groups of thirty-eight turns per group.

Axial dimension per group=21·4 mm. Radial dimension=43 mm.

Axial distance between groups=15 mm. Radial distance windings to core=26·5 mm. Inside diameter of windings=264 mm.

Test impedance at 95 deg. Cent.=3·36 ohms. Test reactance=2·96 ohms.

$$\Sigma w_1^2\ n = 4\times 36^2+10\times 38^2 = 19{,}620. \quad \frac{a_1+a_2+\delta}{a_1+a_2}$$
$$= 1\cdot 35.\quad k\,h = 2\cdot 33.$$

$$\frac{h}{t} = \frac{43}{57\cdot 8} = 0\cdot 744,$$ and from Fig. 3 K=0·613.

Applying formula (6),

$$X = 3\cdot 95\,(19{,}620)\times\left(1\cdot 5+\frac{2\cdot 14+2\cdot 14}{3}\right)\times\frac{96\cdot 2}{4\cdot 3}$$
$$\times\frac{50}{50}\times 0\cdot 613\times 10^{-6} = 3\cdot 13 \text{ ohms.}$$

Therefore, calculated value of reactance=test value—6 per cent.

Example 4.—6·6-kV line. 500 A in neutral. 50 cycles. 10-group winding, consisting of ten groups of fifty-six turns per group.

Axial dimension per group=22·3 mm. Radial dimension=52 mm.

Axial distance between groups=12 mm. Radial distance windings to core=6·5 mm. Inside diameter of windings=167 mm.

Test impedance at 75 deg. Cent.=3·36 ohms. Test reactance=2·99 ohms.

$$\Sigma w_1^2\ n = 10\times 56^2 = 3136. \quad \frac{a_1+a_2+\delta}{a_1+a_2} = 1\cdot 27.$$

$k\,h = 2\cdot 88$.

$$\frac{h}{t} = \frac{52}{56\cdot 8} = 0\cdot 918,$$ and from Fig. 3 K=0·671.

Applying formula (6),

$$X = 3\cdot 95\,(3136)\times\left(1\cdot 2+\frac{2\cdot 23+2\cdot 23}{3}\right)\times\frac{68\cdot 8}{5\cdot 2}\times\frac{50}{50}$$
$$\times 0\cdot 671\times 10^{-6} = 2\cdot 96 \text{ ohms.}$$

Therefore, calculated value of reactance=test value—1 per cent.

Example 5.—6·6-kV line. 1310 A in neutral. 50 cycles. 6-group winding, consisting of two groups of forty-eight turns and four groups of fifty-two turns per group.

Axial dimension per group=57·6 mm. Radial dimension=43 mm.

Axial distance between groups=15 mm. Radial distance windings to core=26·5 mm. Inside diameter of windings=264 mm.

Test impedance=2·83 ohms. Test reactance =2·81 ohms.

$$\Sigma w_1^2\ n = 2\times 48^2+4\times 52^2 = 15{,}420. \quad \frac{a_1+a_2+\delta}{a_1+a_2}$$
$$= 1\cdot 13.\quad k\,h = 1\cdot 04.$$

$$\frac{h}{t} = \frac{43}{130\cdot 2} = 0\cdot 33,$$ and from Fig. 3 K=0·377.

Applying formula (6),

$$X = 3\cdot 95\,(15{,}420)\times\left(1\cdot 5+\frac{5\cdot 76+5\cdot 76}{3}\right)\times\frac{96\cdot 5}{43}$$
$$\times\frac{50}{50}\times 0\cdot 377\times 10^{-6} = 2\cdot 75 \text{ ohms.}$$

Therefore, calculated value of reactance=test value—2 per cent.

Example 6.—6·6-kV line. 1310 A in neutral. 50 cycles. 4-group winding, consisting of two groups of seventy-four turns and two groups of seventy-eight turns per group.

Axial dimension per group=90 mm. Radial dimension=43 mm.

Axial distance between groups=18 mm. Radial distance windings to core=26·5 mm. Inside diameter of windings=264 mm.

Test impedance at 75 deg. Cent.=5·05 ohms. Test reactance=5·03 ohms.

$$\Sigma w_1^2\ n = 2\times 74^2+2\times 78^2 = 23{,}120. \quad \frac{a_1+a_2+\delta}{a_1+a_2}$$
$$= 1\cdot 1.\quad k\,h = 0\cdot 682.$$

$$\frac{h}{t} = \frac{43}{198} = 0\cdot 217,$$ and from Fig. 3 K=0·273.

Applying formula (6),

$$X = 3\cdot 95\,(23{,}120)\times\left(1\cdot 8+\frac{9\cdot 0+9\cdot 0}{3}\right)\times\frac{96\cdot 5}{4\cdot 3}\times\frac{50}{50}$$
$$\times 0\cdot 273\times 10^{-6} = 4\cdot 37 \text{ ohms.}$$

Corrected for unbalancing of the end groups =4·74 ohms.

Therefore, calculated value of reactance=test value—6 per cent.

If instead of using formula (6), formula (2) had been applied, the discrepancies between calculated values and test results would have been as high as 30 per cent.

The above and other test results indicate that the reactance of a transformer having disc type windings may, under the specified conditions, be calculated according to formula (6); that is neglecting the effect of the iron in the core and yokes, with an accuracy of the order of ±6 per cent.

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Aircraft Production

THE following passages are extracted from the reply which the Minister of Aircraft Production (Lieut.-Colonel Moore-Brabazon) made in the House of Commons on Thursday, July 10th, in the debate on Production.

American Planes

An hon. Member from Lancashire said that American machines when they came here had to be overhauled and were so altered as to reduce their speed by 30 miles per hour—to the disgust of Americans. If he had had the experience I have had of aeroplanes, he would know that to reduce the speed of an aeroplane by 30 miles an hour in order to get it operationally fit is no new thing. The aeronautical designer likes to produce a machine which looks well in a glass case. The Air Staff like a flying Christmas tree. If it is a complete Christmas tree it will not fly, and if it is a flying machine which is a pretty thing to look at, it will not fight, and there is always a conflict to reconcile these two points of view, but I know that there is no real reason why anyone should take exception to having an aeroplane slowed up for operational reasons. My hon. Friend the Member for Barnstaple (Sir R. Acland), whose speech I did not wholly hear, asked me whether I could give a guarantee that there would be no victimisation of those giving information about cases where lack of efficiency is alleged. I can assure him that no victimisation will occur anywhere. All we are anxious to do is to get as much efficiency as we can, and any information will be welcome. Then he made a lot of accusations about technical secrets. I can assure him that in the aircraft industry technical secrets are well guarded. As to the question of firms manœuvring for post-war positions, I can tell him that firms like A. V. Roe are making Blenheim machines, which were designed by the Bristol company, and that De Havillands, who have their own types of machine, are making Oxfords. Every firm is making different machines from those designed by itself, and there is no playing up for post-war positions. As for buying out the whole of the engineering industry in order to get on with the war, that is too big a subject for me, but I have no doubt the Prime Minister could say a trenchant word about it.

My hon. Friend the Member for North Aberdeen (Mr. Garro Jones) accused us of having too many American planes in this country without the necessary ancillary equipment. The accumulation of American planes was due to the fact that we took over the French orders which had been placed in America, and that a lot of alterations had to be made to those machines in order to get them operationally suitable for the Air Force. That is why there was an accumulation of that kind. They are now being sent to their operational centres and are doing great work. As to the complaint about the number of types of machines, I would point out that if we take a fighter and put in a different supercharger, we call the new model Mark I, and if we put in four guns instead of two we call it Mark II, whereas if the Americans start with a machine called the Hawk, the first type will be the Tomahawk and the second the Kittihawk, and so it goes on, creating an impression that there are a number of different types, though in effect they are basically one. I am not pretending that there are not too many types in all air forces. From the manufacturing point of view I should like to see fewer, but then that is not the only point of view which has to be considered. It is only lately that we have had unified effort in aircraft production in America, and one had to order the types that existed in America at the time. No doubt, when the industry gets organised, types which are not ordered will fall away, and concentration will take place, as has happened in England, upon certain basic types, and that will be more satisfactory.

Hours and Piecework

One of the points made was that piecework was being paid in astronomical figures. I can only say that the original rates were fixed before there was enough knowledge, perhaps, and they sometimes do rise to very high figures. In order to readjust the position certain machinery has to be used.

On the question of holidays, I entirely agree. No one can work continuously seven days at a stretch. I have only recently given instructions to all aircraft factories to close down on Sundays except for work on acute bottlenecks. If I may borrow a comparison from racing parlance, I would say that you can make a good horse come once and possibly twice, but you cannot flog him round the whole course the whole time. I am certain that the rhythm of production is only possible when you get a proper system in the factories.

Now I may be able to talk about my Ministry. When the Air Ministry was becoming bigger and bigger, it was only right to separate the production side from the Service side. I have had a slight experience of the Air Ministry; it was getting so big as to be unmanageable. The Prime Minister put upon Lord Beaverbrook the very arduous task of getting the production side working as a new Ministry. It is a very unpopular thing to do. The whole of the production side had to be taken away, and he had to ginger up the trade. That did not make him particularly popular up and down the industry. One must remember that when Lord Beaverbrook indulges in an operation he is not very keen on anæsthetics. You must also remember that it was a very critical time, and when my hon. Friend the Member for Mosley (Mr. Hopkinson) said that Lord Beaverbrook got the machines because they had been designed and planned years before, that is not wholly true. It does not do justice to the man. He raided every hen-roost, he speeded up production in every factory, he produced machines which otherwise would never have been produced in any circumstances whatsoever, and he obtained that remarkable drive at a certain time which I believe he and he alone could do. I feel that when the Prime Minister said, "Never . . . was so much owed by so many to so few," Lord Beaverbrook is among them. The name of Max Aitken will be writ high on the scroll of honour. I was Minister of Transport at that time, and I could have murdered him for the way he went through my Department. He swept through every Department of State like Genghis Khan through Asia. It really was a remarkable effort.

I do not know whether any one of you ever visited Lord Beaverbrook in action, and, lest it be forgotten, I should like to paint a little picture of him at work. I do not know if you have seen those cinematograph pictures of newspapers being produced, in which everybody is talking on telephones at the same time, and people are rushing about everywhere—which explains a lot in the newspaper world. I visited Lord Beaverbrook in his office. There were six or seven people in the outer office; nobody questioned my entry, and I walked through and found Lord Beaverbrook interviewing four people at the same time—and quite coherently. He had a telephone in one hand on which he was talking to America, and on another he was ordering his hairdresser to come round and cut his hair in the office. I never in my life met a man with more grasp, more energy, or able to do more things at the same time than that man. He really was indeed tremendous. Tremendous is the only way to describe him. And now I find myself coming in after this Colossus. It is a very serious matter, because when I arrived they looked at me and said, "This is a very poor specimen after that great man."

Mass Production

If there was a mistake made at that time, I think it was that there should have been expansion in the aircraft industry, whereas what happened was that the mass producers of motor-cars were asked to mass produce aeroplanes. One thing you cannot do is to mass produce a thing which was not designed for mass production, and our aeroplanes were certainly

not designed for mass production. That was the mistake; if it had been the other way round—if the aircraft factories themselves had been asked to erect shadow factories—I think it would have been better. Then we come to the present Chancellor of the Exchequer. During his period there was an unexampled expansion right throughout the country, which he was not there subsequently to see.

The aircraft industry is very much maligned, especially the old firms which are called the "ring." Now that we have a great industry, we cannot discriminate between what is called the ring and those outside it, and in this new agreement for prices which is necessary because of the termination of the McClintock agreement, I have refused to negotiate with the Society of British Aircraft Constructors alone, and I have insisted on someone speaking for the whole industry. Along those lines I think we shall reach a satisfactory agreement. Aeroplane prices are not settled at random. We try at the earliest possible moment to make a set price for each machine. There must be an incentive to the designer to make an aeroplane which is easily made, and I want to say that under that agreement if two machines are designed and one of them can be produced at the rate of five a week while the other can only be produced at the rate of one a week, the man who produced the former should get more reward.

What I would like to see is the ideal; that is, to get a highly scientific designer of aeroplanes, let him produce an aeroplane, let it go through its trials, see that it is the right thing. Then I should like to get a cigar-chewing production engineer from Detroit and tell him: "There is the sort of machine I want; make it the easiest way." That could be done, but the trouble is that you can do that when you do not want a modern machine. When you want a modern machine you cannot do it. It is a very tiresome proposition. I have tried to get that organisation, first of all within the firms, but I do not want to impose advice upon the firms which would in any way stop production. The old system of ordering aeroplanes was that the Air Staff said, "We want an aeroplane which will, say, go to Rome carrying such and such a load of bombs, and come back." Some drawings of the more or less suitable machines would be made, and they would be ordered from the point of view of prototypes. The making of a prototype takes from one and a half to two years. The machines would arrive and would be sent down to be tested, one of them would crash, and that would put things back for a long time. Eventually the Air Staff would come along and say that they wanted this and that arranged. Finally, the machine would go into production, and after production it would again be tested and eventually get into the squadrons. The whole of that process, which is perfectly sound, results in the aircraft, from the time it is conceived to the time of getting into the squadrons, taking six years, and being well out of date before it arrived. That was a thoroughly unsatisfactory system, although one that used to occur in peacetime. We cannot do that now.

We have, so to speak, to gamble on these machines. The Air Staff have to tell us what they want. We examine and pass drawings and designs which are put up, and we not only order a prototype but order the planning of production immediately. Very often within a month or two, when the prototype has arrived and is tested for aerodynamic qualities, the Air Staff come along and say they require this and that. We know perfectly well that any aeroplane must go out of date in a certain time, and that there must be changes from one type to another. All these things require a tremendous lot of planning. When you see that one machine is going to disappear, from the operational point of view, you have to splice into that factory another machine. It is very difficult to get everyone in that works working whole time while that splicing takes place. In certain cases it can be done; it has been done in some cases with great success. One trouble of my Ministry is that it is not always making the same thing. It may be that a machine we are making turns out not to be a success operationally. The Air Staff come along and say, "We do not want any more of that." That is where I have great trouble from the point of view of production, because I have not another machine to splice into that factory. These are the worst cases I have of people being without any work. I think then that some of our highly skilled labour must be transferred temporarily one way or another. All these difficulties, I agree, must be explained, so that they can be understood by the workers. There has to be leadership. I have given instructions and all the encouragement I can to ensure that everyone shall be working as a team. I have been criticised for modifications. Hampering as they are from the point of view of production, I can assure the Committee that they have, operationally, beneficial results. On our side, we say, "No," to any modification, unless it can be shown that there is great operational advantage in it. After all, aircraft are for operational use, not just to make a noise in the sky.

Big Bombers

I want to say a word about the big bomber programme. So many people come to me and say, "Why have you got three?" I ought to explain something about that. When the big bomber programme was envisaged it was a new aeronautical conception altogether. Here was a machine which had to fly to Berlin and back, and carry an enormous load—not a load of 1 ton of bombs, but of tons. That had never been done up to that time. It must have astonished the Americans, who thought they had the biggest machine in the world, when they came over here and saw three models of something bigger than they had ever seen. It might have been a success or it might not, but I think it was right to take the long-range view that we should have three arrows to our bow, and they were made. It is true that, now that they are flying, it would have been nice to have concentrated on one and nothing else. But we have three, and we shall go on with three.

I am not pretending that these big aeroplanes, with all their complexities, have not given trouble. This is a very heavy aeroplane. You see them sitting on two wheels with pneumatic tyres. Do you realise that each carries a load equal to a steam roller and a half, and has to gallop across the field at 90 miles an hour? No wonder they sometimes go wrong. It is true that each one of these big, heavy aeroplanes has been grounded owing to troubles—not teething troubles, jaw troubles, I can assure the Committee. My Ministry have had to rush down with all the great technical ability they can muster and put them right. They are flying, and are getting better every day.

Repairs

There is a wonderful system of organisation of repairs, introduced by my predecessor, to which I must pay a tribute. Relative to our production, if you can keep the repairs going, every repaired machine, from an operational point of view, is as good as a new one. There are three types of repairs. There is the type that is done by the squadrons; there is the second, which is done where the machine is wrecked, by civil gangs of experts, who come to deal with it on the spot; and there is the third, under which you have to take the machine back to the works, pull it to bits, and repair it—this is the method for the very big major crashes. This system of travelling experts to go down and deal with a crashed machine has been of enormous help. Then there is the question of storage, of avoiding concentration. That has been a very remarkable thing. At one time we were rapidly drifting to the storage of aircraft, tails up, in vast hangars, so that one bomb might have done in hundreds; but now the machines are well distributed.

Engines

I would like to say a word about engines, because, as I have said before, I was weaned on petrol. I would like to rush along with new engines of vast horsepower as quickly as I can, but the development of engines is one of the slowest things in the world. It takes four years to get an engine from the original drawing to being a satisfactory engine. When I started driving, I started with an engine of about 27 H.P. I remember in the last war that 600 H.P. was looked upon as a remarkable machine. In this war we started with 1000 H.P., and now we have got 2000 H.P. The complexity of aviation engines like that is not to be compared with those simpler engines that we used to make. We have adopted engines with carburetters, but the Germans, owing no doubt to the absence of good fuel, have adopted a fuel injection system rather like that of the diesel engine. They have to be built to get very high indeed, and in order to get higher you have to pump air through their engines. That, we are chasing hard. We now get our fighters from about 35,000ft. up to 37,000ft., and several over 40,000ft. It is an advantage—I do not say that all fighters should—to have a squadron of fighters which can be sitting on top of the others, and this struggle for height is one which is reflected in my Ministry from the point of view of the technical side.

Do not be misled by figures too much. The engine for a fighter alone is of 2000 H.P. and now comes the long-range bomber, with four engines of 1100 H.P. each—75,000 man-hours in the machine alone. You cannot compare the delivery of one of these to the delivery of one Moth. You must compare the bomb load carried, the range, and that sort of thing. What does it all mean? Where have we got and how do we stand? I am not on the operational side. I have just to supply the goods, but if in the time that Lord Beaverbrook made that great effort to defeat the enemy by making fighters—if he could do it then, then the chances of the enemy invading this country to-day would be very much poorer indeed. As for the other side—the offensive side—where are we going? I do not say that we have got exactly all we want to get yet, but we are coming along. Members will remember the famous Wednesday and Saturday raids on London. It is an easy thing to raid London from France, and it is a much more difficult thing to raid Berlin from London, but I can assure hon. Members that it will not be many months before a raid like that on London will be child's play compared with that which we will be able to make on Berlin.

ERRATUM.—"The World We Hope to Live In," footnote, page 2, col. 1, for "Money or Something for Nothing," read "Money as Nothing for Something."

Sixty Years Ago

Cooper's Hill College

IN our issue of July 22nd, 1881, we devoted a leading article to the status and future of Cooper's Hill College, an institution—now no longer existing—which was founded when the Duke of Argyll was at the India Office, for the purpose of training civil engineers for service under the Government of India. For many years engineering works in India had been largely carried out by military engineers, but in a number of instances those officers had been called upon to discharge duties for which they were unfitted. Costly mistakes were made, and the Government lost hundreds of thousands of pounds annually in bad engineering. Dams were built without adequate exploration of the bedrock, with the result that the water escaped through fissures below the foundation. Barracks were erected which failed to last more than a few years, and which were so hot that the health of the troops quartered in them suffered severely. In these circumstances the Government sought to recruit fifty civil engineers in this country for service in India. Many entered for the competition, but a considerable number, after passing the examination and being accepted, refused to proceed abroad unless the rate of pay was raised from £400 a year to a minimum of £600. The Government refused to yield on that point, and driven to its wits' end to obtain civil engineers for India, instituted Cooper's Hill Training College. The education given at the College reached a very high standard, but it was entirely theoretical, and when graduates from the College reached India it was found that for the most part they failed to give satisfaction because of their lack of practical experience. Cooper's Hill, we said in our leading article, had been a failure. It turned out educated gentlemen, trained mathematicians, good linguists, and admirable draughtsmen, but it did not produce engineers in the full sense of the term. Its future existence was imperilled, and unless considerable changes were made in its organisation it would have to be closed. A new scheme, we understood, was being drawn up whereby the India Government would be largely relieved of the financial burden of maintaining the College. It was, we understood, the intention to make it self-supporting. A hundred or more pupils were to receive their training at it on payment of fees, and from them ten or a dozen would be selected each year for appointment to posts in India. . . . Cooper's Hill College is still remembered for the excellence of its teaching. That it had eventually to be closed may be explained by the fact that in the course of time other educational institutions grew up and made it unnecessary for the Government of India to maintain a special engineering training establishment of its own.

SANITATION FOR AMERICAN ARMY CAMPS

IN connection with the establishment of a number of permanent camps for the United States Army, a firm of consulting engineers has drafted the basic requirements for sewage treatment plants. The systems of treatment vary widely, including sludge digestion, activated sludge, preliminary and secondary filtration, chlorination, and single-stage and double-stage bio-filters. The quantities assumed average 70 gallons per capita per day, with a maximum of 140 for several hours, and a peak of 210 gallons. Suspended solids will average 460 parts per million, or 0·27 lb. per capita per day. Grit chambers are not generally used, but if provided they should be cleaned by hand and the grit disposed of by burial. Bar screens of 1in. to 1½in. openings may be cleaned by hand or by mechanical devices, the screenings to be buried or burned in an incinerator. In primary sedimentation tanks the period is three hours for trickling filter plants, 1½ hours for activated sludge and 6 to 7½ hours for bio-filter plants. Trickling filters are designed for 5000 population per acre-foot in mild climate, or 4000 where severe winters prevail. Final sedimentation tanks, 10ft. to 12ft. deep, are to have a flow not exceeding 800 gallons per square foot per twenty-four hours, or 1600 gallons in two-stage bio-filter plants. Heated sludge digestion tanks are to have 2 to 3 cubic feet per capita, or 50 per cent. more capacity for unheated tanks or for activated sludge plants. For Imhoff tanks the capacity to be 2 to 2½ cubic feet per capita with plain sedimentation alone, or 3 to 3½ cubic feet with trickling filter. For sludge drying beds in warm climates, without underdrains or filtering material, the capacity may be 2 to 3 square feet per capita. For plants of the trickling filter type the figures may be ½ to 1 square foot, or 1 to 1½ square feet for plants of the activated sludge type. In any case, provision is made for chlorination of the effluent. The selection of system of treatment depends largely on size and area of the camp and the general character of its surroundings.

The Engineer

JULY 25, 1941

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Half-Yearly Index

With the object of conserving paper, the number of copies of the Index to Volume CLXXI will be limited. Copies will be sent to all Institutions and Public Libraries on our mailing list and subscribers may obtain copies on application gratis and post free.

RADIO LOCATION

To heighten the effect of their latest appeal for technicians, the Government has disclosed something of the progress made with the new art of radio location, hitherto a well-guarded secret. A radio beam moving with the velocity of light ranges out in all directions and returns with information as to the presence of approaching aircraft. The story told in the Press is as wonderful as that of Noah, the dove, and the Ark—but more incredible! This essential scouting duty used to be allotted to the sound locator, which had found itself beaten by the enormous speeds of modern aircraft. Some of these attain to velocities of more than half that of the sound wave itself, so that an aeroplane, detected by sound waves which left it when 10 miles away, would by the time the warning was received have already covered half that distance, and the time left before it flew overhead would be but one minute, entirely insufficient to allow any interceptor squadron in the neighbourhood to gain height for attack. The situation is improved when the sound locator can make its detection at 20 miles instead of 10 miles, but that, though possible on some occasions, is far from usual. Hence some new method had to be discovered.

Investigations initiated nearly seven years ago have borne fruit so successfully that the new method, in active development before the war started, is now in use on an immense scale. By day and by night ever since the war began these friendly radio waves have probed the skies, and have informed the watchers on the ground of the location of all aircraft approaching our shores, and in ample time to enable the probable targets to be warned and the defending squadrons to get to the correct height for attack. As these squadrons are fitted with radio telephones they can be kept informed of changes of course on the part of the enemy, and so be guided to the point where the desired interception should take place. Since radio is unaffected by cloud, mist, or darkness, the same good and useful work can continue under all conditions. Radio seems, in fact, to be the perfect tool for the task. The detection of hostile aircraft had for many years, we believe, been laid down as one of the many responsibilities of the War Office, but this new method was initiated and developed by the Air Ministry, and it is to the credit of the latter Department that they were, in those seemingly remote days of peace, ready to take on new tasks of considerable experimental difficulty for which officially they were in no way responsible. It is probably to the credit of the War Department that they did not think it needful for "all trespassers to be prosecuted"!

At the time when this new enterprise was being set on foot, the civil aviation authorities at busy airports were at their wits' ends to know what to do to regulate effectively the growing volume of incoming and outgoing traffic. What they needed, and needed badly, was an indicator of some kind which would tell them the position of all aircraft in the neighbourhood, and whether coming in or going out. The information was even more needed under conditions of poor visibility than on clear days, and that was just when it was hardest to get. Here, however, was the earnestly sought invention to satisfy all their needs, but, alas, not available for civil purposes, since its primary use had to be that of air defence and secrecy at that stage was necessary. It must have been a tantalising situation for those in authority on air matters. In the coming days of peace the new invention will be free for civil use, and we foresee a great gain to the civil air lines in safety to life and in punctuality and frequency in service. It is reasonable to hope that it may prove possible, in addition, to safeguard aircraft which have to fly on crowded routes from collision with each other. If this can be done, it should not be impossible for some similar means to be adopted to minimise the risk due to collisions at sea. It would seem as though we may be approaching a day when the presence of fog on land and sea will cease to be the great nuisance it now is. At last we have a detecting probe which can penetrate it easily and bring back information.

This discovery is yet another instance of a practically useful tool deriving from scientific research work undertaken purely for the sake of seemingly useless knowledge. The scientific basis of the system has been known all over the world for years past. Radio waves, like all other waves, can be reflected as in the case of light and sound. We must not go into further details, but it may be said that the merit of radio location lies in the skill and ingenuity of those who have built up a workable apparatus on a familiar scientific fact—just as the inventors and improvers of the dynamo applied to a practical and useful purpose Faraday's discovery of induced currents.

Of Institution Libraries

ONE of the services that the greater engineering institutions render to their members is the provision and upkeep of valuable libraries. The service is one too little appreciated. For the thousands of members living at a distance there is some excuse for indifference, but for those whose homes and offices are in or near London there is none. A technical library is an essential to every engineer. There he may make himself acquainted with the latest books and there search for information upon subjects with which he is not conversant. There, too, he may find that reawakening of the intellect which arises from the study of the history of engineering and the biography of the famous men who have made it. And, finally, in these stormy days, and even in those of normal stress, where can one better seek refreshment of the spirit than in the peace which lies upon a library and that gentle titillation of the intelligence which comes with the browsing upon books? Who knows what new thought may be born, what new idea quickened into life by a sentence, a picture, a mere word, in a volume taken at hazard from the shelves.

Let it be admitted that engineers, taken i' the lump, are not booky people. Perhaps, like Aloysius Horn, they "don't hold with reading if it can be helped." For every member upstairs in the library of any Institution you may find a dozen downstairs in the reading room, busy with the current technical papers. Who are we not to praise to the nines that admirable practice! But newspapers are newspapers and "books is books." There is room enough for both and to spare. The newspaper keeps you up to the mark in your profession. It is for ever cleaning the windows so that you may see more clearly, putting on a new tile here and there, sometimes adding an attic or a mansard to an old building. But one must remember that the real foundations and the main structure—long ceased to be news—are encrusted in books. In them is written down the whole story of the wonderful fabric we call engineering. It is through them that we learn to understand it aright. Then there are books and books. Some are text-books, whose function was to teach you in your youth the answers to examiners' questions; others are penny-in-the-slot books, drop in a coin and take out the information; others are mere tables of reference, which no one calls literature; yet others are descriptive or illustrative, they put you wise on the Arts and Manufactures—as the term used to run—of the day. Others, like Varé's "little pink parrot," are the "pick of the bunch," they are biographical, historical and philosophical. There is the best browsing ground; there the greatest refreshment. There, with his feet on the earth, a man's head may be up in the Empyrean amongst the gods. And who knows when it may snap back again, like a stretched elastic, with some new thought that may be turned to account. The library reminds one of the mushroom that the wise old caterpillar, smoking his hookah, sat upon. Nibble from one side or the other and you may grow greater or less, as Alice did, to suit your convenience. Now in the tree tops finding inspiration for wonderful thoughts; now down in the grass seeking humbly for commonplace things. But one or the other, it is a pleasurable adventure. Where in the whole world can one dream dreams better than in a well-stocked library, and where would engineering be if men did not dream dreams and see visions?

And what of the Warden of the Books, the Librarian. You may look far to find men happier and more helpful in their profession. They take a real joy in their charges and are never weary of trying to help those who turn to them for guidance. Their knowledge is astounding. They can always tell you where the goldfields are and where the biggest nuggets may be found. Our personal obligations to the Librarians of the Institutions are countless. Never do they fail us. They direct, they search, they lend, and with infinite patience winnow their own capacious minds and their card indexes to satisfy our exacting requests. No library is complete without a good librarian and we cannot imagine any city better served in that respect than London, but that is because we know it best. We are convinced from experience that, like beer, all librarians are good—a bad one is not a librarian at all—and can hardly bring ourselves to admit that some may be better than others.

Obituary

COLONEL CECIL LEE HOWARD HUMPHREYS

MANY civil engineers will learn with sorrow of the death, at his brother's home, Berrins Hill, Ipsden, Oxfordshire, on Friday, July 18th, at the early age of forty-seven, of Colonel Cecil Lee Howard Humphreys, the senior partner in the firm of Howard Humphreys and Sons, consulting engineers, of 17, Victoria Street, London, S.W.1, and 7, Eldon Square, Reading, who since December last has ably filled the office of Director of Works at the Ministry of Works and Buildings. Colonel Humphreys suffered somewhat in his health since his return from Dunkirk, and some time ago he underwent an operation. He died after a short illness.

He was born on September 7th, 1893, and received his general education at Westminster School. In 1911 he joined his father's business, and in the next three years gained practical training in civil engineering in that office. In 1914 he was among the first Territorials to arrive in France, and beginning as a private in the Honourable Artillery Company, he served in France, Salonika, Egypt and Palestine, and rose to the rank of Staff Captain.

In 1919 he rejoined his father's practice and was chief assistant until 1925, when he was made a junior partner in the firm. On the death of his father in 1930 he became senior partner. His work covered many different branches of civil engineering and included the design and supervision of water and drainage schemes, sewage schemes, roads and railways and the construction and reconstruction of bridges. We may recall, among many others, the drainage schemes carried out by his firm for the city of St. Albans, the city of Georgetown, in British Guiana, and those for Lagos, in Nigeria, and Kampala, in Uganda, besides which there were many others in Middlesex and the Home Counties, and other parts of England and Wales. A large water scheme was that for the central part of the island of Trinidad. His road work included many inspections and reports for the Postmaster-General, for which his firm acts as consultant, and for the National Traction Engine Association. One of the largest road schemes, which included the building of an important viaduct, described in THE ENGINEER, was the reconstruction of the Chester-Holyhead road near Penmaenmawr. This work formed the subject of a paper that Colonel Humphreys gave before the Institution of Civil Engineers in April, 1937, which gained for him an award of a Telford Premium. Another paper which was presented to the Institution in February, 1939, was that on "The Water Supply of Kumasi, in the Gold Coast Colony." That paper was also awarded a Telford Premium, which, however, Colonel Humphreys was unable to accept, as he was then serving on the Council of the Institution. The bridge work carried out by Colonel Humphreys included the reconstruction of the Norfolk bridge at Shoreham and designs for bridges on the Hull and Selby road. His work included the inspection of London bridges for the London General Omnibus Company and other authorities and a report on the reconstruction of the Worcester bridge over the River Severn. Some later schemes on which he was engaged included those for ship locks at Faversham, carried out for the Faversham Navigation Company, railway connections for the Cheshire works of the British Dyestuffs Corporation, and the reconstruction of Littlehampton harbour and a report upon the question of the flooding of the River Arun.

On the outbreak of the present war Colonel Humphreys went to France as a Lieut.-Colonel in the Royal Corps of Signals, and served in the 2nd Signal Corps, being awarded the Order of the British Empire for distinguished services in the field. After the evacuation of the British Expeditionary Force from Dunkirk, Colonel Humphreys was appointed Chief Signal Officer in the 3rd Corps.

Last December he was invited by Lord Reith to accept the appointment of Director of Works on the formation of the Ministry of Works and Buildings, an appointment which offered him still greater opportunities for public service than those he had hitherto held and in which he should have succeeded well.

Colonel Humphreys was a man of keen interests and many-sided activities, who was honoured alike for his wide engineering knowledge and his unfailing kindness and cheerfulness. His services to the nation can ill be spared, and his loss will be deeply felt. He was a member of the Council of the Institution of Civil Engineers, a member of the Institution of Mechannical Engineers a member of the Institution of Water Engineers, the Association of Consulting Engineers, the American Society of Civil Engineers, and the Société des Ingénieurs de France. He took great interest in the education of engineers and was a joint author with Mr. G. Howard Humphreys, M.A., M. Inst. C.E., of a book on "The Training of a Civil Engineer."

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

A GEOMETRICAL PROBLEM

SIR,—In a recent issue of THE ENGINEER, George Cohen, Sons and Co., Ltd., propounded an interesting and apparently simple geometrical problem, which, they said, they had been unable to solve. I know that the problem has aroused some interest among your readers, but as I have seen no reference to it in your correspondence columns, I venture to offer a solution. Doubtlessly other solutions will have been found by other readers.

The problem was this: Given any triangle and any point external to it; to draw a line through the point which will divide the triangle into two equal areas. The construction to be employed is to be purely geometrical—that is to say, to be carried out solely with the aid of a straight edge and compasses—and, naturally, should be as simple as possible. The procedure I have followed is to solve the problem algebraically and then to interpret the algebraic solution geometrically.

Algebraic Solution.—In Fig. 1 A B C is the given triangle and O the given point. It is required to

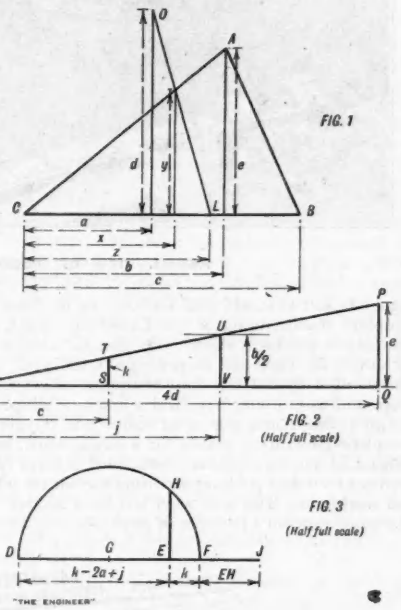


FIG. 1

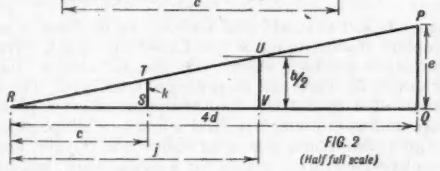


FIG. 2
(Half full scale)

FIG. 3
(Half full scale)

"THE ENGINEER"

draw the line O L which will cut the triangle into two equal areas. Drop perpendiculars from O and A on to the base C B. The form of the triangle is defined by the length of the base c, the height e and the distance b along the base at which e lies. The position of the point O is defined by the co-ordinates a and d. These are the given or known data. The quantity to be found is the distance C L or z. To this unknown it is convenient to add two others, namely, x and y, the co-ordinates of the point of intersection of O L with the side A C of the triangle.

The line O L divides the triangle into two equal areas, one of which is itself a triangle. The area of this triangle is $\frac{1}{2} z y$ and since it is to be equal to half the area of the triangle A B C we have

$$\tfrac{1}{2} z y = \tfrac{1}{4} c e \text{ or } y = c e / 2 z.$$

From similar triangles we have

$$e/y = b/x \text{ or } x = b y / e = b c / 2 z.$$

Also from similar triangles we have

$$d/y = (z-a)/(z-x) \text{ or } z d - x d = z y - a y.$$

Substituting in this expression the values of x and y already found, we get the equation

$$2 d \,.\, z^2 - c e \,.\, z + c (a e - b d) = o,$$

the solution of which is

$$z = c e / 4 d \pm \sqrt{[(c e / 4 d)^2 - \tfrac{1}{2} c e a / d + \tfrac{1}{2} b c]}.$$

Let $c e / 4 d = k$ and $j k = \frac{1}{2} b c$. Then

$$z = k \pm \sqrt{k (k - 2 a + j)}.$$

It will be seen that mathematically there are two solutions. The second one, with the minus sign, corresponds with the case in which the line O L cuts A C and B C produced towards the left.

Geometrical Solution.—Construct a triangle P Q R, Fig. 2, of which the base R Q $= 4 d$ and the height Q P $= e$. Lay off R S $= c$ and erect the perpendicular S T. Then S T : R S = Q P : R Q. Hence

$$S T = R S \,.\, Q P / R Q = c e / 4 d = k.$$

Draw a line parallel with R Q at a distance $b/2$ above it. From the point U at which this line cuts R P drop the perpendicular U V. Then

$$R V : U V = R S : S T. \text{ Hence}$$

$$R V \,.\, S T = U V \,.\, R S \text{ or } R V \,.\, k = b c / 2. \text{ Therefore}$$

$$R V = j.$$

Along a straight line, Fig. 3, lay off a distance D E $= k - 2 a + j$ and a distance E F $= k$. Bisect D F at G and describe a circle of radius G D. From E erect a perpendicular to cut the circle at H. Then since D H F is a right-angled triangle, we have $E H^2 = D E \,.\, E F$ or

$$E H = \sqrt{k (k - 2 a + j)}.$$

Lay off F J = E H. Then

$$E J = k + \sqrt{k (k - 2 a + j)} = z.$$

Hence E J = C L.

London, July 14th. T. W. C.

THE WORLD WE *COULD* LIVE IN

SIR,—As a student of engineering as well as of economics, may I congratulate you on your far-sighted policy in encouraging engineers to take an interest in economics and monetary matters and permitting them to wrestle with some of these problems in your pages? For, after all, what engineering contract does not involve the payment of money, money being a vital and necessary factor in permitting the engineer to carry out his work? Your excellent publication has for long years dealt with innumerable phases and developments in engineering, though I believe your issue of July 4th was the first occasion on which you have referred to the money side, which will play such an important part in the reconstruction after victory has been gained.

Can we picture the situation when that happy day is reached and reconstruction can be put in hand? There will be the engineers with their plans drawn up, the raw materials available for use, the factories ready to produce, even though some of them will have to turn over to peacetime routine; there will be the labour seeking steady and satisfactory employment, yet everything will be dependent on the supply of money. Each is a vital link in the chain and with any link missing nothing can go ahead. Engineers as a body are fully conversant with all the links in the chain, except perhaps that of the supply of the money or credit, which in the past has too readily been considered as outside their province. As we are so concerned with the future perhaps it may be wise for engineers to investigate this money subject more carefully in case we are not quite clear what money or credit is and where it originates. Is it, for example, a matter of taxation or of loans, and, if the latter whose money is lent to whom?

A consultation of the "Encyclopædia Britannica," fourteenth edition, 1929, in Vol. 3, under "Banking and Credit," states:—"Banks create credit. It is a mistake to suppose that Bank Credit is created to any important extent by the payment of money into the Banks." Vol. 15, under "Money," states:—"Banks lend by creating credit; they create the means of payments out of nothing." Take one further point from the address to the shareholders of the Midland Bank by the Right Honourable Reginald McKenna, P.C., as chairman, on January 25th, 1924, when he said:—"I am afraid the ordinary citizen will not like to be told that the Banks can, and do, create and destroy money. The amount of money in existence varies only with the action of the Banks in increasing or decreasing deposits and bank purchases. Every loan, overdraft or Bank purchase creates a deposit, and every repayment or Bank sale destroys a deposit." It is probable that the findings of such authorities as the "Encyclopædia Britannica" and the chairman of the Midland Bank will come as a surprise to a good many, but in accepting these facts new possibilities are immediately opened up.

While no one would decry the normal and proper function of the banks, it is only logical that the right of creating or destroying money or credit belongs to the State and not to any private institution or section of the community, which under present conditions charges interest for the credit or money created out of nothing. If the credit or money is created by the State, acting as trustee of the people, the State does not have to pay interest and therefore there is no cause for taxation to meet the interest.

Before proceeding any further, what do we mean by money ? The vast bulk of the purchasing media in any modern State consists of book entries, somewhat misleadingly described as bank deposits. For every paper pound there are nine book entry pounds. The debiting and crediting of individual accounts in accordance with the instructions given on cheques does not cause any variation in the total of purchasing media as represented by bank deposits. The total can only be altered by the banks themselves in the manner described by Mr. McKenna. Money was introduced as a convenient medium for the exchange of goods and services. Obviously, it is simpler for a man possessing a cow and wanting a gramophone to sell his cow for money and then buy with some or all of it the gramophone rather than lead the cow into Harrods and exchange it for the gramophone of exactly equal value. (How much time would be lost in bargaining for equal values instead of settling the deal by coins or a cheque of prescribed amount.) Money, or credit, however, has been put to uses other than those for the exchange of goods and services and has itself been regarded as a commodity to be bought and sold, not only nationally, but internationally. Instead of being the servant of mankind, money has become the master.

The reason why in times of slump or depression food is actually destroyed whilst millions are underfed is, we are told, because these people have not enough money. Let us be quite clear, therefore, that the State must have the right to create money, using the banks as their agents, so that the financing of the post-war reconstruction may be carried out without piling up heavy interest bearing debt.

Obviously, there is a limit to the extent to which the creation of credit can be carried, and this limit is the point at which inflation occurs. It is recognised that the point is reached when the increase in effective demand represented by money outstrips the corresponding increase in the supply of goods and services and so causes a rise in price. If a unit of money is to be an honest measure of value, it is fundamentally right that the price index should be maintained at a constant level. A price index already exists and it is not beyond the wit of man to maintain a constant price level by regulating the amount of credit and money in circulation provided always that new money can be spent instead of being lent into existence. The banks have a definite place in industry and a real service to perform for which they require reasonable remuneration. It is, however, the right of the State, as representing the people, to control the volume of credit of the people, and until this right is re-established so long will money be the master of mankind and not the servant.

The above proposal for monetary reform, which is already being widely discussed, is based on fundamental facts, and can obviously take care of all phases of reconstruction, thus providing for full and satisfactory employment of the peoples of this country. With the whole country fully employed the Government revenue in peacetime would be amply assured without heavy taxation, on the principle that many hands make light work and the burden of unemployment with all its demoralisation would be eliminated. But the end of reconstruction in five or ten years would not be the end of this happy period, for so long as man will consume, so long will there be a demand for goods and services, assuming always that the supply of money is properly regulated. There is no doubt that adequately to feed, clothe and house the people of this country a high level of employment is permanently required, quite apart from that required for the export trade. And this brings us to international trade, for which there is also a satisfactory solution, though this is another matter which might be dealt with on some other occasion.

Although the question of economic and monetary reform is one which is far too important to be a party political matter, may I conclude by quoting the words of the Right Honourable W. L. Mackenzie King, Prime Minister of Canada, who summed up the situation in 1935 in the following sentence :—

"Until the control of currency and credit is restored to the Government and recognised as its most precious and most sacred responsibility, all talk of the Sovereignty of Parliament and Democracy is idle and futile."

I am using a *nom-de-plume* which surely constitutes the only reply to the foregoing challenge. YNOT.

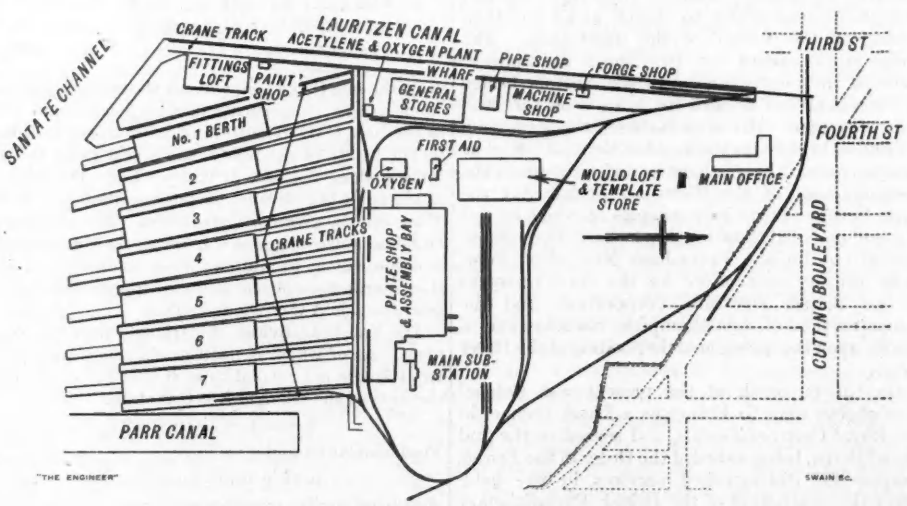
Todd-California Shipbuilding Corporation Shipyard at Richmond, California

IN an article which we published in our issue of June 20th we were able to give some preliminary particulars of the new shipyard constructed at Richmond, on the east shore of San Francisco Bay, California, by the Todd-California Shipyard Corporation, for the construction of thirty 7000 gross ton cargo ships for the British Purchasing Commission in America. A general aerial view of the yard taken at the beginning of June shows the well-advanced state of the yard, in which four ships were then laid down, and work was well advanced on the other slipways. It is understood that the yard is now busily engaged, and that all that remains to be done is to complete the dredging of the Lauritzen Canal. The plan we reproduce shows the general design and lay-out of the yard and its principal buildings. These consist of a mould loft and template store, a plate shop, and assembling bay, and a machine shop, other sections comprising a general stores and oxygen and acetylene generating plants for welding work, largely utilised in the hull construction, and general offices, with canteen and parking accommodation for officials and workmen. The new yard has been leased to the shipbuilders from 110 acres of land which is made up of holding of the Parr-Richmond Terminal Corporation, Proctor and Gamble, and other firms. There was, we understand, considerable competition among cities in California to accommodate the new shipyard, and several offers were considered. The offer of Mr. Alfred Parr, of San Francisco, was, however, finally accepted on account of the excellent facilities as regards foundations and the deep water which is available on the site for launching and fitting out. It is expected that in this yard the services of not less than 7500 men will be required when the work is in full swing.

Since the laying of the keel of the first of the British ships on April 14th, seventy-eight days after work had been begun, a further enterprise was started on a neighbouring site at Richmond, adjoining the factory of the Ford Motor Company and not far from the yard in which the British ships are being built. A site of over 200 acres was, the *Pacific Marine Review* reports, acquired from the Atchison, Topeka and Santa Fé Railroad Company and the Parr-Richmond Terminal Corporation. This company is known as the Richmond Shipbuilding Corporation, and its president is Mr. H. J. Kaiser, the newly elected president of the Todd Corporation. It is estimated, according to our American contemporary, that some 1,500,000 cubic yards of dredging will be carried out, and over 750,000 cubic yards of rock will be needed to complete the site, and make it suitable for shipbuilding operations. The construction of the second yard is now well in hand, and the keel of the first American ship will be laid in a few months' time. It is expected that a further 7000 men will find employment in this second yard. The *Pacific Marine Review* gives further particulars of the two classes of ships which are to be built at the two shipyards we have mentioned. In the Todd-California Shipbuilding Corporation's yard the British ships, it says, will be classed by Lloyd's Register of Shipping, and will have a length between perpendiculars of 416ft., an extreme breadth of 57ft., and depth to the shelter deck of 37ft. They will have a deadweight carrying capacity of about 10,000 tons, with a gross tonnage of about 7000. Steam propelling machinery is to be installed, and it will comprise, our contemporary states, triple-expansion steam engines of about 2500 I.H.P., taking steam from coal-fired Scotch boilers. The ships will have a designed speed of from 10 to 11 knots.

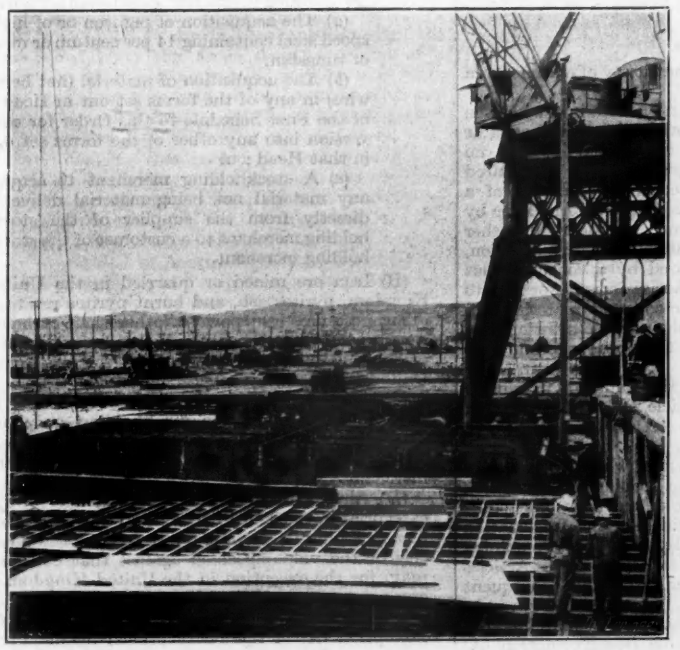
The ships for the American emergency type cargo service, which have been ordered by the United States Marine Commission, and are under construction in

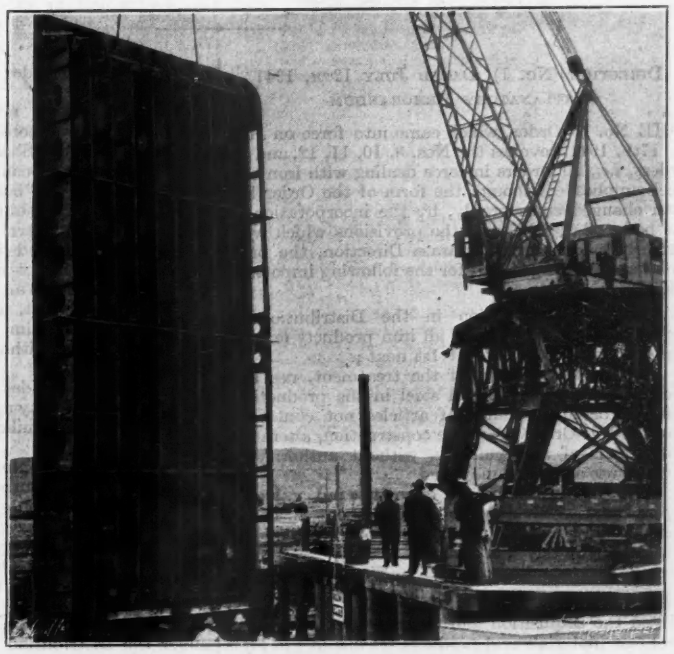
AERIAL VIEW OF TODD-CALIFORNIA YARD AT RICHMOND



PLAN OF RICHMOND SHIPYARD

WELDED TANK BOTTOM AT RICHMOND SHIPYARD





the Richmond Shipbuilding Corporation yard, are to have a speed of between 10 and 11 knots, and will have a length of about 425ft. They are to have a deadweight carrying capacity of approximately 10,000 tons, and in general they follow very closely the British design. The engines will consist of reciprocating units of about 2500 I.H.P., which will take steam from oil-fired boilers of probably water-tube design.

As already mentioned, welding is taking a prominent part in the construction of the hulls of these ships. We are able to reproduce herewith views of the first section of a tank bottom completed at the Todd-California yard, which is being moved from the assembly bay. The two views of this large section show its construction, and will indicate the large scale on which welding is being applied. It is estimated that all the ships will be completed and delivered within two years of the laying of the first keel.

Large Motors and Alternators

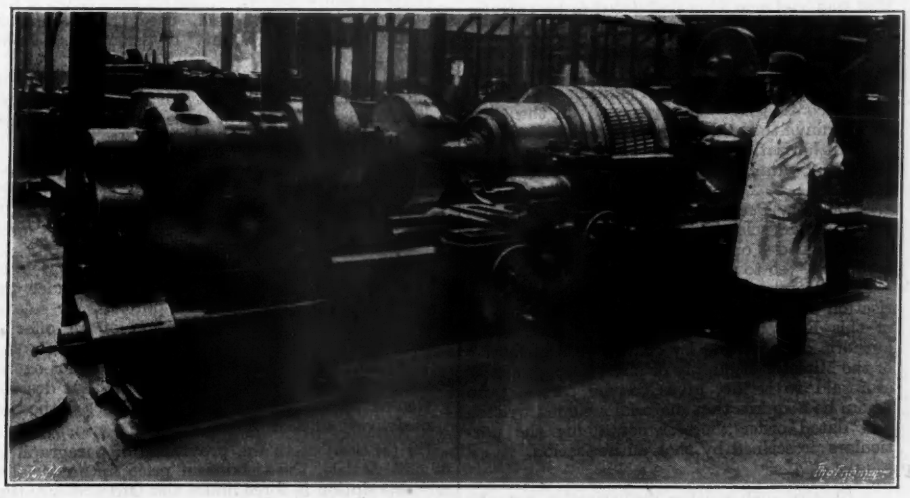
WE are informed by Higgs Motors, Ltd., that the firm is now manufacturing large motors and alternators up to 600 H.P. The extended range includes alternators, polyphase A.C. variable-speed commutator motors, slip-ring induction motors, low starting current squirrel-cage motors and auto-synchronous motors. Considerable attention has been paid to the provision of ample air ducts to sectionalise the stator and rotor cores and the fixing of baffles where necessary, so as to direct a sufficient supply of cooling air throughout all parts of the machine. Further constructional details include substantially dimensioned shafts, roller bearings at the driving end, and standardised and interchangeable terminal boxes with stud type terminals and fittings to accommodate the various types of cable which may be used.

The variable-speed commutator motor is an extension of the type which has been made in the smaller sizes for the past three years. It consists essentially of an induction motor stator with a wound rotor brought out to a commutator. Speed variation is accomplished by means of a separate induction regulator which produces a variable voltage without phase shift. The injection of this voltage into the rotor circuit of the motor gives the necessary speed variation with a shunt characteristic so that the variation of speed with load for a given regulator setting is very small. Commutation is usually difficult on A.C. motors and often limits the size of motor which can be manufactured. This difficulty is claimed to be removed by the employment of a special commutating winding on the armature, which, although connected to the commutator and therefore in parallel with the main armature winding, is arranged so that the corresponding coils of the main and commutating winding, which are connected together, do not have the same coil pitch and do not lie in the same slots. Briefly, the commutating winding provides a discharge path for the commutated energy and serves also to reduce the reactance of the coil undergoing commutation.

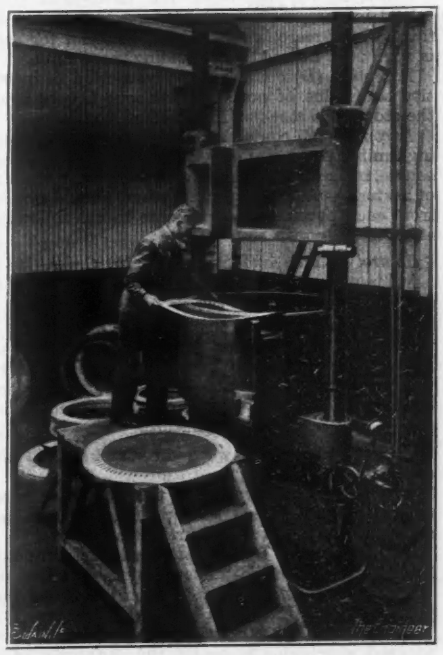
This variable-speed commutator motor can be made in any size up to 480 H.P. at 1200 r.p.m. with speed ranges of 10 to 1, or higher in certain cases. The speed variation is against constant torque and gives a horsepower which varies in proportion to the speed.

The construction of the induction regulator used in connection with these motors is interesting. It follows closely along the lines of the wound rotor induction motor. Two units are mounted together vertically above one another and the base carries a small motor driven fan, which blows cooling air through the windings and cores. Control of the regulator is by means of a hand wheel and worm drive on to the regulator shaft. Alternatively, a small pilot motor may be employed geared down to rotate the worm shaft at a suitable speed. These regulators are also used for supply voltage regulation. They will maintain constant output voltage with varying input voltage either with hand regulation or automatically under the control of a voltage relay and a pilot motor on the regulator. The output voltage need not be the same as the input. For example, a group of 500-volt motors can be run off 400-volt mains by this means.

The squirrel-cage motor embodies a standard stator of the usual construction, but the rotor is entirely special, having three rows of slots. The upper row contains a squirrel-cage winding consisting of bars brought out to two end rings in the usual manner. The slots in the second and third rows are alternate. A shallow slot in the second row is followed by a deep slot in the third row, then by a shallow slot, and so on.



ARMATURE OF 480 H.P. COMMUTATOR MOTOR



ASSEMBLY OF STATOR PLATES

These slots contain bars which have been previously bent in the form of a U shape. One side of a U piece is inserted in a shallow slot and the other side is introduced into a deep slot. The two free ends of this single-turn coil are then brazed on to a common end ring at the one side of the rotor only. Thus this lower winding, which is situated underneath the squirrel-cage winding, has a definite coil pitch. By the choice of a suitable coil pitch it is possible to eliminate any objectionable harmonics which would otherwise create a depression in the speed torque curve. Thus any tendency to crawling is entirely eliminated.

Machines can be made for direct starting if required, even on the large sizes. The starting current is approximately 3 to 3½ times full load, or even less in favourable circumstances, with a starting torque of about twice full-load torque.

New Iron and Steel Order

DIRECTION (No. 1), DATED JULY 12TH, 1941

EXPLANATORY MEMORANDUM

THE No. 15 Order, which came into force on July 17th, 1941, revokes the Nos. 8, 10, 11, 12, and 13 Orders, *i.e.*, all Orders in force dealing with iron and steel supplies. Although the form of the Order has been changed considerably, by the incorporation in the body of the Order of the provisions which were formerly set out in a separate Direction, the principles are unchanged, but for the following important additions :—

(i) The incorporation in the Distribution of Steel Supplies Scheme of all iron products (except pig iron) from September 1st next ;

(ii) The prohibition of the treatment, use and consumption of iron and steel in the production, repair or maintenance of articles not controlled under this Order or for the construction, alteration or repair of any building, without authority to treat, use and consume ; and

(iii) The limitation in quantity and value of purchases which may be made without authority by any one person from the stock of a stockholding merchant in any one quarter.

To deal with the Order in detail—

1. Article 1, which in the No. 8 Order prohibited the acquisition and disposal of the iron and steel raw materials and products set out in the First Schedule except by or to a licensed purchaser, now deals only with acquisition. Acquisition is prohibited with certain exceptions, most of which consist of the exemptions from licence which in previous Orders were contained in Direction No. 1. These exceptions are tabulated in Article 1 as follows :—

Exception (*A*) contains the main provisions of the Scheme for the Distribution of Steel Supplies with the addition of iron products, including iron castings, but not including pig iron. The main features of the Scheme remain unaltered, although there has been some alteration in wording.

Exception (*B*) exempts from licence purchases of home iron ore, pyrites ash, burnt pyrites residues, manganese ore, boot and shoe grindery and machine staples, when acquired for use in the United Kingdom. In addition, all iron powder, except carbonyl iron powder, is free from licence when acquired for use in the United Kingdom.

Exception (*C*) continues the exemption contained in paragraph 5 (*a*) of the No. 8 Order, in favour of a merchant acquiring material for sale in turn to a licensed stockholding merchant.

Exception (*D*) embodies the restriction in quantity and value of purchases without licence from the stock of a stockholding merchant ; and

Exception (*E*) contains a similar provision allowing limited purchases of certain products from any source, including stockholding merchants. Suppliers of material under these exemptions should obtain from each purchaser a certificate to the following effect :—

" *Control of Iron and Steel* (*No.* 15) *Order*, 1941, *Exemption from Licence under Article* 1, *Exceptions* (*D*) *and* (*E*).

I hereby certify that this purchase of
together with any other purchases of material of the same category made by me during this (month) (quarter) under the above exemptions do not exceed cwt. in quantity or £ in value.
Signature."

(Delete whichever word in brackets is not applicable.)

The quantities and values in the certificate must not, of course, exceed the quantities and values set out in the Third and Fourth Schedules.

If a purchaser from a stockholding merchant holds a Distribution Scheme authorisation on Form M he must use that authorisation and not purchase under Exception (D) or (E).

Exception (*F*) authorises acquisition by a licensed purchaser or under the authority of a special or general direction issued by the Minister of Supply.

The exemptions from acquisition licences contained in paragraph 4 of Direction No. 1 to the No. 8 Order have been discontinued in view of the transfer of iron to the Distribution Scheme, although such exemptions are continued (as mentioned below) until August 31st next, in respect of iron products, except pig iron. For the same reason the exemption of iron castings at a certain stage of production contained in paragraph 1 of Direction No. 1 to the No. 8 Order has been discontinued. In addition, the exemption from licence of pressings, tanks and cylinders contained in paragraph 1 of Direction No. 1 to the No, 8 Order has been discontinued because of the withdrawal of those articles from control by an alteration (see paragraph 8 below) made in the First Schedule.

2. Article 2 deals with the disposal of the materials set out in the First Schedule. No person may dispose of such materials except to a purchaser acquiring under Article 1 or under the authority of a licence or a Direction.

3. Article 3 is a new article dealing with the treatment, use and consumption of iron and steel as mentioned above. Shortly the position is that no treatment, use and consumption licence is required if the material has been acquired by means of a Distribution Scheme authorisation on Form M or by Iron and Steel Control licence or under the other Exceptions contained in Article 1. In addition, where material is not acquired by a consumer but that consumer holds an authorisation on Form M to acquire, he can treat, use or consume material produced or owned by him, for the purpose mentioned in the authorisation, without a treatment, use and consumption licence.

4. Article 4 provides for the fixing of maximum prices in the same way as Article 2 of the No. 8 Order.

5. Article 5 is similar to Article 3 of the No. 8 Order.

6. Article 4 of the No. 8 Order, which provided for the furnishing of returns, the keeping of books, &c., and for the inspection of works, has been omitted as these powers are now contained in the Information and Records (Industry) Orders. The remaining Articles in the new Order are similar to Articles appearing in the No. 8 Order with a few consequent alterations.

7. No stockholding merchant may acquire material under the Distribution Scheme (see Exemption (A) to Article 1) or iron under paragraph 4 of Direction No. 1 to the No. 8 Order (see the Direction to the No. 15 Order), except when the material is delivered directly from the supplier of the stockholding merchant to a customer of the stockholding merchant. Accordingly, as hitherto, a stockholding merchant may acquire material for stock only if he holds a stock licence from the Iron and Steel Control. A stockholding merchant may not treat, use or consume stock material without a licence to do so.

8. By heads 4 and 5 in the First Schedule to the Order, control has been extended to cover iron powder and carbon electrodes (except illuminating, welding or primary battery electrodes). Pressings have been omitted from head 7 so that they are no longer controlled, although, of course, the products required for their production are still controlled. The definition of constructional steel work has been amended.

9. The Fifth Schedule to the Order contains a list of maximum controlled prices.

10. Direction No. 1 (at the end of the Order) authorises the acquisition of iron (except pig iron) without licence up to August 31st, 1941, for the purposes and by the purchasers set out in paragraph 4 of Direction No. 1 to the No. 8 Order, but any such orders outstanding at August 31st and orders placed after that date must be authorised under the Distribution Scheme.

THE CONTROL OF IRON AND STEEL (No. 15) ORDER

Whereas it appears to the Minister of Supply to be necessary for maintaining supplies and services essential to the life of the community and expedient that this Order should be made :

Now, therefore, the Minister of Supply in exercise of the powers conferred on him by Regulations 55 and 98 of the Defence (General) Regulations, 1939,[1] hereby orders as follows :—

1. No person shall acquire or agree to acquire any material mentioned in the First Schedule to this Order, except that—

(A) Material mentioned in Head 7 of the said First Schedule may be acquired—

(1) For any purpose, by any " Department " named in the Second Schedule to this Order, which gives to the person from whom it acquires that material a written and dated order therefor headed—

Control of Iron and Steel—Distribution Scheme.

" Department " Symbol (stating the symbol allotted to that " Department " in the First Column of the said Second Schedule).

Authorisation Number (stating the authorisation number selected by that " Department ").

Delivery Period (stating the period number or numbers selected by that " Department ") ; and signed " on behalf of (name of ' Department ') " so to sign ; or

(2) For any purpose prescribed in the authorisation hereafter referred to in this sub-head of this Exception, by any person who, being authorised in writing by or with the authority of the Minister of Supply or any " Department " aforesaid so to do, gives to the person from whom he acquires that material a signed written and dated order therefor containing the particulars prescribed by that authorisation.

Provided that—

(i) Any such written authorisation may be amended, varied, or revoked either by the Minister of Supply or by the " Department " giving it ; and

(ii) Nothing in this Exception shall authorise

(*a*) The acquisition of pig iron or of high-speed steel containing 14 per centum or more of tungsten.

(*b*) The acquisition of material (not being wire) in any of the forms set out in Head 7 of the First Schedule to this Order for conversion into any other of the forms set out in that Head ; or

(*c*) A stockholding merchant to acquire any material not being material delivered directly from the supplier of the stockholding merchant to a customer of the stockholding merchant.

(B) Iron ore mined or quarried in the United Kingdom, pyrites ash, and burnt pyrites residues, manganese ore, iron powder (other than carbonyl iron powder), and boot and shoe grindery and machine staples, may be acquired for use in the United Kingdom, by any person.

(C) Any material mentioned in any licence to acquire it granted to a stockholding merchant may be acquired for the purpose of supplying it to that stockholding merchant for stock by any merchant.

(D) Any material included in any one of the categories in the Third Schedule to this Order, but not exceeding in any one quarter either the quantity or the value specified against that category, may, for the execution in the United Kingdom of any purpose, be acquired by any person (not being a person authorised to acquire that material under Exception (A) of these Exceptions) by making a purchase of that material from the stock actually held at the time of such purchase by a stockholding merchant.

(E) Any material included in any one of the categories in the Fourth Schedule to this Order but not exceeding in any calendar month either the quantity or the value specified against that category, may be acquired for the execution in the United Kingdom of any purpose, by any person not being a person authorised to acquire that material under Exception (A) of these Exceptions ; and

(F) Any material may be acquired under the authority of and in accordance with a licence granted, or a special or general Direction issued, by the Ministry of Supply.

2. No person shall dispose of or agree to dispose of any material mentioned in the First Schedule to this Order, except—

(A) to a person acquiring that material by virtue of the provisions of Article 1 of this Order.

Provided that nothing in this Exception shall authorise any stockholding merchant to dispose of any material otherwise than in the form in which that material was acquired by him ; or

(B) Under the authority of and in accordance with a licence granted or a special or general Direction issued by the Minister of Supply.

3. No person shall treat, use, or consume any material mentioned in the First Schedule to this Order in the production, repair, or maintenance of any article not mentioned in the First Schedule to this Order or for the purpose of the construction, alteration, or repair of any building, except that—

(A) Material acquired by virtue of the provisions of Article 1 of this Order may, for the purpose for which it has been acquired, be treated, used, and consumed, by the person who has so acquired it.

(B) Material produced or owned by a " Department " or person referred to in Exception (A) to Article 1 of this Order, and being material of the same description as any material for which that " Department " or person is, under that Exception, authorised to give a Distribution Scheme order prescribed by that Exception, may, for the purpose and within the quantity prescribed in that authorisation, be treated, used, and consumed whilst that " Department " or person is so authorised ; and

(C) Any material may be treated, used, and consumed under the authority of and in accordance with a licence granted or a special or general Direction issued by the Minister of Supply.

4. (1) Subject to the provisions of paragraph (4) of this Article, no person shall buy or sell or agree or offer or invite an offer to buy or sell any material for which a maximum price is in force under this Order, except at a price which is either—

(*a*) Not in excess of the maximum price for material of that description in force under this Order at the time of such purchase or sale or agreement or offer or invitation of an offer to buy or sell ; or

(*b*) Defined in such a way that it cannot exceed such maximum price for material of that description as may be in force under this Order at the time of delivery of that material.

(2) (*a*) Subject to the provisions of paragraph (3) of this Article, the maximum price for material of any description in force under this Order at any time shall be ascertained from the Fifth Schedule to this Order and the related schedules.

[1] S.R. & O., 1939 (No. 927), I, page 715.

(*b*) The Fifth Schedule to this Order and the related schedules may be varied and related schedules may be revoked and further related schedules may be added to this Order by special or general Direction issued by the Minister of Supply.

(3) In the case of any material mentioned in the First Schedule to this Order being material of a description for which no maximum price is in force under this Order, any person shall comply with any notice given (or special or general Direction issued) by the Minister of Supply—

(i) Requiring that person not to buy or sell or agree or offer to buy or sell any such material at a price exceeding a maximum price to be fixed by the Minister of Supply for that material; or

(ii) Fixing the maximum price for that material.

(4) In the case of any material being material for which a maximum price is in force under this Order, the Minister of Supply may, provided he is satisfied by any person that by reason of transport or other difficulties that person is not able to obtain a reasonably adequate supply of any such material through his usual channels of supply, authorise that person to buy and any other person to sell to him any or such material in such quantity and at such price in excess of the maximum price therefor as the Minister of Supply may, having regard to such difficulties and the public interest, deem reasonable.

(5) In this Article the expressions "buy" and "sell" include any acquisition of ownership and any disposal of ownership respectively in pursuance of any agreement to sell whether such agreement was made before or after the coming into force of this Order.

5. (1) Notwithstanding anything contained in Article 1, 2, or 4 of this Order, in any proceedings in respect of any alleged contravention of any provision of any of those Articles by any purchase or other acquisition, sale, or other disposal or agreement, it shall be a defence if the defendant shall prove that the material with respect to which the contravention is alleged was at the time of the agreement for acquisition or disposal or purchase or sale or at the time of appropriation to the performance of that agreement situate outside the United Kingdom.

(2) Notwithstanding anything contained in Article 4 of this Order, in any proceedings in respect of any alleged contravention of any provision of that Article by any sale or purchase or agreement, it shall be a defence if the defendant shall prove that the material with respect to which the contravention is alleged was under the agreement delivered or agreed to be delivered, either—

(i) Outside the United Kingdom; or

(ii) On board a ship for exportation to some place or places outside the United Kingdom;

and in any proceedings in respect of any alleged contravention of any provision of that Article by an offer or invitation of an offer, it shall be a defence if the defendant shall prove that the offer or invitation of an offer was for the purchase or sale of material which was intended to be either—

(*a*) Situate outside the United Kingdom at the time of the proposed agreement for purchase or sale or of appropriation to the performance of that agreement; or

(*b*) delivered either—

(i) Outside the United Kingdom; or

(ii) On board a ship for exportation to some place or places outside the United Kingdom.

6. (1) Nothing in Article 4 of this Order shall prohibit or restrict the entering into and carrying out of any transaction between the Minister of Supply and any other person at such price as may be agreed between the Minister of Supply and that person.

(2) For the purposes of this Order, where any material is acquired by or disposed of to a carrier or warehouseman or servant acting in the ordinary course of his business or employment as such, that material shall be deemed to be acquired by or disposed of to the person on whose behalf or to whose order the carrier or warehouseman or servant so acquires that material, and not by or to the carrier or warehouseman or servant; and where any material is acquired from or disposed of by a carrier or warehouseman or servant acting as aforesaid, that material shall be deemed to be acquired from or disposed of by the person on whose behalf or by whose order the carrier or warehouseman or servant so disposes of that material, and not from or by the carrier or warehouseman or servant.

7. (1) The holder of any licence granted or authorisation given under this Order shall comply with any conditions contained or incorporated in that licence or authorisation.

(2) If any licence granted or authorisation given under this Order is revoked by the Minister of Supply, the holder of that licence or authorisation shall forthwith deliver up that licence or authorisation to the Minister of Supply or as directed by him.

8. (1) In this Order the expression "related schedule" means any one of the related price schedules for iron and steel products lodged with the Minister of Supply for the purposes of this Order and certified as a "Control of Iron and Steel (No. 15) Order, 1941: Related Schedule No.....," by the signature (dated with the date of certifying) of a Principal Assistant Secretary in the Ministry of Supply; the number of which Related Schedules at the coming into force of this Order is 97.

(2) In this Order the expression—

"Quarter" means any one of the periods of three months ending on March 31st, June 30th, September 30th, or December 31st in any year; and the expression

"Acquire" includes the acquisition, and the expression "dispose of" includes the disposal of

(i) Ownership or any proprietary interest; or

(ii) The right to possession; or

(iii) Possession, whether or not accompanied by any acquisition or disposal of any ownership or of any proprietary interest or of the right to possession.

9. (1) The Control of Iron and Steel (No. 8) Order, 1940,[2] the Control of Iron and Steel (No. 10) Order, 1940,[3] the Control of Iron and Steel (No. 11) Order, 1940,[4] the Control of Iron and Steel (No. 12) Order, 1940,[5] and the Control of Iron and Steel (No. 13) Order, 1940,[6] are hereby revoked; but—

(*a*) Any licence granted or having effect as if it were granted under the Control of Iron and Steel (No. 8) Order, 1940, or that Order as varied by any of the other Orders mentioned above in this Article, and which has not expired or been revoked, shall have effect as if it were a licence granted under Article 1 of this Order, and shall be deemed to have been so granted; and

(*b*) Any authorisation given under Paragraph 2 of the Control of Iron and Steel (No. 8) Order, 1940, Direction No. 1,[7] and which has not been revoked shall have effect as if it were an authorisation given under Exception (A) to Article 1 of this Order, and shall be deemed to have been so given.

(2) This Order shall come into force on the 17th day of July, 1941; and may be cited as the Control of Iron and Steel (No. 15) Order, 1941.

Dated this 12th day of July, 1941.

A Principal Assistant Secretary in the Ministry of Supply.

THE FIRST SCHEDULE

1. Iron Ore (excluding Iron Pyrites and Cupreous Pyrites, but including Pyrites ash and burnt Pyrites residues, whether in briquetted or other form).

2. Manganese Ore; Ore, concentrate or residue containing Molybdenum or Vanadium.

3. Ferro-Alloy of any kind, Molybdenum Metal, Calcium Molybdate, Molyte, bricks and briquetted forms of Molybdenum Dioxide and of Molybdenum Trioxide, Tungsten Metal, Tungsten Carbide, Cemented Carbide Hard Metal, Calcium Silicide.

4. Iron Powder.

5. Carbon electrodes, not being illuminating, welding, or primary battery electrodes.

6. Cinder and Scale produced during the manufacture or mechanical treatment of Iron and Steel.

7. Iron and Steel in any of the following forms:—

Pig; Ingot; Billet, bloom, slab; Tinplate bar, sheet bar; Plate, medium plate, sheet (and whether coated or uncoated); Angle, channel, tee, joist, piling section, other sectional material (and whether fabricated or not); Round, rod, square, hexagon, flat, other section and shape (and whether black or bright); Rail, sleeper, fish-plate, sole-plate; tinplate, terne plate, black plate, silver-finished plate; Hoop, strip (and whether coated or uncoated, and whether hot or cold rolled); Tube, pipe and standard fittings therefor; Tyre, axle, wheel; Casting, block for forging, block for pressing, forging, stamping; Colliery arch, and accessories therefor, pit prop; Bolt, nut, screw stud, washer, rivet, screw; Railway spring (and whether laminated or coiled); Wire rod; Coated or uncoated wire (whether plain or barbed), wire rope, wire strand, wire netting, wire chain link fencing, wire mesh, wire reinforcement fabric mesh, wire rod reinforcement fabric mesh, wire nail, wire staple; or Constructional steel work for inclusion in the structure of a building.

THE SECOND SCHEDULE

Symbol (to which "B" may or may not be added).	Department.
H.O.	Home Office
A.R.P.	Ministry of Home Security
Ad.	Admiralty
Ad.M.	Admiralty
W.O.	War Office
M.S.	Ministry of Supply
A.M.	Air Ministry
M.A.P.	Ministry of Aircraft Production
S.D.	Scottish Departments
B.T.	Board of Trade
B.E.	Board of Education
M.H.	Ministry of Health
A.F.	Ministry of Agriculture and Fisheries
M.T.	Ministry of War Transport
M.F.	Ministry of Food
O.W.	Ministry of Works and Buildings
P.O.	General Post Office
M.D.	Mines Department
P.D.	Petroleum Department of the Mines Department
E.C.	Electricity Commissioners
N.I.	Ministry of Commerce of Northern Ireland
Ind.	War Supply Board (India)
A.R.	Emergency Services Organisation (Ministry of Aircraft Production)
L.A./A.R.	Local Authorities (Ministry of Health)

THE THIRD SCHEDULE

Category.	Description.	Quantity.	Value.
(i)	HEAVY CARBON STEEL PRODUCTS, namely:—		
	Plates 3 mm. thick and thicker; sections, joists and bars not included in category (ii)	10 tons	£125
(ii)	RE-ROLLED AND DRAWN CARBON STEEL AND IRON PRODUCTS, namely:—		
	Sections 4 united inches and under; channels 3in. web and under; joists under 3in. web; hoop and strip; rounds, squares and hexagons under 3in., flats 5in. wide and under, including spring steel bars	2 tons	£25
(iii)	Sheets	1 ton	£20
(iv)	Tinplate	3 tons 18 cwt. or 39 double boxes	£130
(v)	Terne plate	„	„
(vi)	Black plate	„	„
(vii)	Silver-finished plate	„	„
(viii)	Baling and strapping wire	2 tons	£120
(ix)	Coated or uncoated wire not being baling or strapping wire, whether plain or barbed, wire strand, wire netting, wire chain link fencing, wire mesh, wire nails, wire staples	10 cwt.	£40
(x)	Alloy steel ingots, billets, blooms and bars (not including high-speed steel containing 14 per cent. or more of tungsten)	3 tons	£75

THE FOURTH SCHEDULE

Category.	Description.	Quantity.	Value.
(i)	Ferro Alloy of any kind (except ferro-vanadium)	1 ton	£40
(ii)	Calcium molybdate	2 cwt.	£40
(iii)	Molyte	2 cwt.	£40
(iv)	Tungsten metal	2 cwt.	£60
(v)	Tungsten carbide	40 lb.	£40
(vi)	Cemented carbide hard metal	8 lb.	£40
(vii)	Calcium silicide	1 ton	£100
(viii)	Iron casting	2 cwt.	£10
(ix)	Bolt, nut, screw stud, washer	8 cwt.	£40
(x)	Rivet	8 cwt.	£40
(xi)	Screw	8 cwt.	£40
(xii)	Wire rope	2 cwt.	£10
(xiii)	Cast iron pipes and standard fittings therefor	1 ton	£20
(xiv)	Wrought iron and steel tubes and standard fittings therefor; malleable cast iron pipe fittings	10 cwt.	£15

THE FIFTH SCHEDULE

MAXIMUM UNITED KINGDOM PRICES FOR IRON AND STEEL PRODUCTS

Unless otherwise stated, prices set out or referred to in this Schedule are basis prices per ton for the quantity (if any) shown delivered to buyer. Other prices (related or additional) for products of the classes set out below and extras, allowances, and rebates, shall be those provided for in or calculated in accordance with the Related Schedules and the Standard List therein referred to.

IRON ORE—

All prices are f.o.t. at quarry or mine.

	£ s. d.
Hematite—	
(*a*) For use in blast-furnaces, mined in the counties of Cumberland, Lancashire, and Glamorgan, containing 50 per cent. iron and 8 per cent. silica	1 7 6
The above maximum price shall be both—	
(i) increased by the aggregate of	
(*a*) 6d. per ton for each 1 per cent. by which the iron content exceeds 50 per cent., and	
(*b*) 1½d. per ton for each 1 per cent. by which the silica content falls short of 8 per cent.; and	
(ii) reduced by the aggregate of—	
(*a*) 6d. per ton for each 1 per cent. by which the iron content falls short of 50 per cent., and	
(*b*) 1½d. per ton for each 1 per cent. by which the silica content exceeds exceeds 8 per cent.	
(*b*) Lumpy, for use in steel furnaces	2 3 6
Jurassic—	
(*a*) Quarried or mined in the Frodingham district of Lincolnshire	0 3 9
(*b*) Quarried in Oxfordshire	0 3 0
(*c*) Quarried or mined in Leicestershire, Northamptonshire, Rutland, or Lincolnshire, other than provided for under (*a*), with an iron content as produced exceeding 34 per cent.	0 4 6
(*d*) Quarried or mined in Leicestershire, Northamptonshire, Rutland, or Lincolnshire, other than provided for under (*a*) and (*c*)	0 4 0
Calcined—	
(*a*) Quarried in Oxfordshire	0 7 0
(*b*) Quarried or mined in Leicestershire, Northamptonshire, Rutland, or Lincolnshire	0 8 6
(*c*) North Staffordshire Coal Measure	1 11 0

FERRO ALLOYS AND ALLIED MATERIALS—

	Per lb. s. d.	
Ferro-Molybdenum and Molyte	6	0 of Molybdenum content
Calcium Molybdate	5	9 of Molybdenum content
Ferro-Tungsten	5	1 of Tungsten content
98/99 per cent. Tungsten Powder	5	2½
Ferro-Vanadium	15	6 of Vanadium content

CINDER AND SCALE—

	£ s. d.
(*a*) Good Clean Scale for use in open-hearth steel furnaces, f.o.t. producing works	1 4 0
(*b*) Scale for use in blast-furnaces or sintering plants	1 5 6
(*c*) Ball Furnace Cinder containing not less than 68 per cent. iron, for use in blast-furnaces	1 8 0
(*d*) All other Cinder for use in blast-furnaces	1 3 0

PIG IRON—

Basic, delivered station or siding to—	
(*a*) South Wales, N.E. Coast, Lincolnshire, Scotland, Mersey Ports, Lancashire, Cheshire, N. Wales, North Staffs, and Yorkshire (including Sheffield)	6 0 6
(*b*) South Staffordshire and all other districts	6 3 0
Hematite, No. 1 Mixed Nos. S. & P. over 0·03 per cent., but not exceeding 0·05 per cent., delivered station or siding to—	
(*a*) Scotland, N.E. Coast, and West Coast England	6 18 6
(*b*) Sheffield	7 4 0
(*c*) Birmingham	7 10 0
(*d*) Wales—Welsh Iron	6 14 0

[2] S.R. & O., 1940, No. 496.
[3] S.R. & O., 1940, No. 1118.
[4] S.R. & O., 1940, No. 1910.
[5] S.R. & O., 1940, No. 1138.
[6] S.R. & O., 1940, No. 1757.
[7] Printed at the end of S.R. & O., 1940, No. 496.

PIG IRON (*continued*)— £ s. d.

Foundry and Forge, delivered station or siding—
(*a*) No. 3 Iron, Class 2 :
(1) Middlesbrough 6 8 0
(2) Birmingham 6 10 0
(*b*) Phosphorus over 0·50 to 0·75 per cent., Birmingham 6 17 6
(*c*) Phosphorus, over 0·10 to 0·50 per cent., Birmingham 7 0 6
(*d*) Scotch No. 3 Foundry Iron, delivered Grangemouth 6 4 9

Cylinder and Refined—
(*a*) North Zone 8 14 0
(*b*) South Zone 8 16 6

Refined Malleable—
Birmingham and South Staffordshire 8 11 6

Cold Blast—
South Staffordshire 11 7 6

Blast-furnace Ferro-Manganese—
76 to 80 per cent. Mn Standard Grade 18 10 0

FORGING INGOTS—
Up to 0·60 per cent. C 13 1 6

BILLETS, BLOOMS, AND SLABS FOR RE-ROLLING—
Basic—
(*a*) Soft U.T. (100-ton lots) 12 5 0
(*b*) Soft T.G., up to 0·25 per cent. C (100-ton lots) 12 10 0
(*c*) Hard, 0·42 to 0·60 per cent. C 13 17 6
(*d*) Silico-Manganese 17 5 0
(*e*) Free Cutting 14 10 0

Siemens-Martin Acid—
(*a*) Up to 0·25 per cent. C 15 15 0
(*b*) Case-hardening 16 12 6
(*c*) Silico-Manganese 17 5 0

BILLETS, BLOOMS, AND SLABS FOR FORGING, DROP FORGING AND STAMPING—
Basic—
(*a*) Soft, up to 0·25 per cent. C 13 17 6
(*b*) Hard, over 0·41 to 0·60 per cent. C 14 10 0

Acid—
(*a*) Up to 0·25 per cent. C 16 5 0
(*b*) Case-hardening 17 2 6
(*c*) Silico-Manganese 17 15 0

ALLOY STEELS—

	0·6–1 per cent. Nickel.	Nickel-Chrome, Ni 2·75–3·75, Cr 0·6–1·25 per cent.	Nickel-Chrome-Molybdenum, Ni 2·75–3·75, Cr 0·60–1·25, Mo 0·20–0·60 per cent.
	£ s. d.	£ s. d.	£ s. d.
Billets, 2in. up to and including 10in.	19 0 0	30 17 6	37 13 6
Stamping Bars, ¾in. dia. and up, round or equivalent sectional area ...	26 7 6	39 12 6	47 11 6

STAINLESS STEEL AND IRON—

	Austenitic.	Martensitic.
Steel Billets, 2in. and larger, square and Gothic sections	1s. per lb.	8½d. per lb.

SHELL STEEL— £ s. d.
Rounds, Squares, Gothic Billets or other Similar Sections, 3in. and up—
Over 0·30 per cent. up to and including 0·60 per cent. carbon 16 5 6

SHELL STEEL DISCARDS—
(*a*) *Shell Steel Discard Billets* where supplied in small sizes 2in., 3in. and 4in. square, or rolled to the finished shell steel size, which can be rolled direct by the re-roller 12 5 0
(*b*) *Other Discards, in the shape of Billets, Blooms or Slabs* requiring further processing before capable of being rolled into standard sizes of billets for the re-rollers 10 5 0

HIGH-SPEED STEEL—

	14 per cent. Tungsten.	18 per cent. Tungsten.	22 per cent. Tungsten.
Bars, per lb....	3s. 0d.	3s. 10d.	4s. 4d.

TINPLATE AND SHEET BARS— £ s. d.
Delivered station or siding in not less than 6-ton lots 12 2 6

WIRE RODS—
Basic, all sizes with exception of 6-gauge and over 7/0 gauge delivered in all districts in United Kingdom except (*a*) Birmingham and Scotland, and (*b*) Southern Joint Area :
Soft Basic, 0·08 to 0·25 per cent. C. 17 7 6
Hard Basic, 0·42 to 0·60 per cent. C. 21 2 6
Free-cutting 20 2 6
Acid, up to 0·85 per cent. C., all sizes with exception of 6-gauge and over 7/0-gauge, delivered all districts :—Ordinary 24 13 6

MANUFACTURED IRON—

	Crown Iron.	No. 3 Bars.	No. 4 Bars.
	£ s. d.	£ s. d.	£ s. d.
(*a*) English and Welsh delivery, usual districts ...	15 12 6	12 10 0	13 0 0
(*b*) Scottish delivery, station or siding, usual districts	15 12 6	13 12 6	13 17 6
(*c*) Irish delivery, f.o.q. Belfast	16 5 0	13 2 6	13 12 6

HEAVY STEEL PRODUCTS—

Delivered buyer's nearest station or siding except where otherwise provided in the Related Schedules	Joists, Sections, and Bars (Angle Basis).	Plates.	Boiler Plates.
	£ s. d.	£ s. d.	£ s. d.
(*a*) North-East Coast, Northern Joint Area, Scotland, Belfast shipyards and shipbuilders at Thorne, New Holland and Gainsborough ...	15 8 0	16 3 0	17 0 6
(*b*) Leeds and District, Midland Area and South Wales	15 8 0	16 5 6	17 3 0
(*c*) Southern Joint Area ...	15 10 6	16 8 0	17 5 6
(*d*) f.o.q. Belfast (other than shipyards)	15 13 0	16 8 0	17 5 6

Medium Plates (under ¼in. thick) all deliveries :—
Weighing 6 lb. or more per square foot 17 17 6
Weighing less than 6 lb., but not less than 4·81 lb. per square foot 18 7 6
Chequered Plates (¼in. thick and upwards) delivered to :—
(*a*) North-East Coast and shipbuilders at Thorne, New Holland and Gainsborough 17 13 0
(*b*) Northern Joint Area, Scotland, Leeds and District, Midlands and South Wales, Southern Joint Area 17 15 6

RAILS—
Heavy Rails, 60 lb. per yard and over, lots of 500 tons and over, f.o.t. makers' works 14 10 6
Light Rails, light flange rails, up to and including 25 lb. per yard 16 15 0

COLLIERY ARCHES AND ACCESSORIES—
4in. by 2½in. by 2in. and 4in. by 2½in. by 2½in. single radius with straight, horseshoe or splayed legs with one fish-plate joint, complete with one pair of fish-plates and the necessary bolts and nuts 17 6 0
Arches as above, but *without* fish-plates, bolts and nuts 17 4 0
Fish-plates (for Arches) alone 22 8 0
Plain Cambered Girders, 4in. by 2½in. by 2in. and 4in. by 2½in. by 2½in., with minimum camber of 2in. in centre, for use underground only 16 19 0
Corrugated Straps, Roofing or Bent Bars 16 0 6

RE-ROLLED STEEL PRODUCTS—
Angles and Tees, 4 united inches and under, and *Channels*, 3in. web and under : Basis U.T. 17 2 0
Bars—Flats, 5in. wide and under, and *Rounds and Squares*, under 3in. U.T. 17 12 0
Free Cutting Bars—Rounds 19 16 6
Hoop and Strip, hot rolled (excluding hoop and strip for Gas, Steam and Water Tubes), U.T. 18 7 0
Hoop and Strip, cold rolled, hard bright in coils (not annealed), 1½in. to 6in. by 0·032in. and thicker 26 2 9
Products made from Basic Hard Steel, 0·42 to 0·60 per cent. C 19 5 0
Products made from Siemens-Martin Acid Steel, up to 0·25 per cent. C 21 2 6
Spring Steel Bars, Laminated—
(*a*) Basic, 0·42 to 0·60 per cent. C, Water Hardening 19 5 0
(*b*) Acid, 0·42 to 0·60 per cent. C, water hardening 22 16 0
Siemens-Martin File Steel, long lengths, 12in. and up—
(*a*) Acid 24 7 6
(*b*) Basic 21 14 6
Ferro-concrete Bars, delivered station or siding 16 19 6
Rivet, Bolt and Nut Bars (4-ton lots)... ... ... 17 15 0
Glazing Tees, Special Glazing Bulk or long stalked Tees 21 5 0
Sash and Casement Sections, Main Standard Cottage Zeds 20 18 0
Gate Channels 19 16 0

BRIGHT STEEL—
Bars—
(*a*) Mild steel to no analysis or tests 24 14 0
(*b*) Tested and guaranteed, 28 to 32 tons tensile 25 14 0
(*c*) Free Cutting B.S.S. 32, Grade 4 ... ... 27 7 0
Flats, not tested or guaranteed 34 9 0

SHEETS—
Black, 24 G., 4 tons and over of basis quality... ... 22 15 0
Galvanised, Corrugated 24 G., 4 tons and over of basis quality 26 2 6

TINPLATE, TERNE PLATE, AND BLACK PLATE—
Tinplate, Coke quality, per basis box (I.C. 20 by 14, 112 sheets, 108 lb.), f.o.t. makers' works ... 1 9 9
Terne Plate, Unassorted Light Ternes, ordinary quality, sold per basis box (28 by 20, 112 sheets, 216 lb.), f.o.t. makers' works 2 15 9
Black Plate, Rectangles, unassorted, C.A. quality, 28/14 B.G. per ton, f.o.t. makers' works ... 22 14 9
Tubes, Pipes, and Fittings.
Gas List Wrought Iron and Steel Tubes and Fittings.
Weldless Tubes, B.S.S. 806, *Classes "B" and "C."*
Perkins Tubes.
Loose Flange Joint Tubes.
Wrought Iron and Hot Finished Steel Boiler Tubes.
Steel Pipes to B.S.S. 534, *Table I.*
A.P.I. Line Pipe.
Malleable Pipe Fittings.
Steel Conduit Tubes.
Vertically Cast Iron Pipes and Spun Iron Pipes.
Standard Socket and Spigot Special Castings.
Cast Iron Drain Pipes.
Cast Iron Drain Pipe Fittings.
Angle Cast Iron Pipes for Gas and Water Purposes.
The prices set out in the Related Schedules.

WIRE AND WIRE PRODUCTS— £ s. d.
Mild Steel Wire, catch weight coils 6/8 standard wire gauge for sales by makers in 2-ton lots—
Hard drawn 22 5 0
Mild drawn... ... ... 23 15 0
Annealed 23 15 0
Galvanised Barbed Wire, 2 or 4 point, 2 ply, 12½ gauge, for sale by makers in 2-ton lots 31 5 0

FORGINGS—
Prices set out in the Related Schedules plus the percentage additions in operation at October 31st, 1940, plus in the case of Related Schedule No. 77, 4 per centum, and in the case of Related Schedules Nos. 78 and 79, 10 per centum.

STEEL CASTINGS—
Prices set out in the Related Schedules, with the addition of 9 per cent. plus 25s. per ton.

RAILWAY TYRES, AXLES, DISC CENTRES, SOLID WHEELS, AND STANDARD TYPES OF COMPLETE WHEELS AND AXLES—
Prices set out in the Related Schedules plus £2 2s. 6d. per ton.

RAILWAY COIL SPRINGS— £ s. d.
Spiral Buffer and Draw Springs—
R.C.H. Drawing, No. 209A/1, each 0 11 2
R.C.H. Drawing, No. 109A/2, each 1 6 3
Volute Buffer and Draw Springs—
R.C.H. Drawing, No. 209A/8, each 0 12 11

LAMINATED RAILWAY SPRINGS—
Bearing Springs, 5 plate ordinary wagon, 4in. wide by ⅝in. plates 33 14 0
Buffing Springs, 14 plate with double double lug hoops 35 11 6

IRON CASTINGS—
For Rainwater and Soil Goods, Gutters and Connections, the prices set out in the Related Schedules with the addition of 21 per centum.

RIVETS— £ s. d.
4in. by ½in. diameter, 2-ton lots, ex works, delivered Midland Area—
Mild Steel 22 10 0
Wrought Iron 20 0 0

BOLTS AND NUTS—
Hot Spelter Galvanised Mushroom Roofing Bolts and Nuts—
½in. by ½in., ex works, 2s. 3d. per gross.
Bright Gutter Bolts and Nuts, ½in. by ½in., ex works, 1s. 9d. per gross.

THE CONTROL OF IRON AND STEEL (No. 15) ORDER, 1941 : DIRECTION No. 1, DATED JULY 12TH, 1941

Under the Control of Iron and Steel (No. 15) Order, 1941, the Minister of Supply hereby issues the following Direction :—

1. Notwithstanding anything in Article 1, 2, or 3 of the Order, any iron (not being pig iron) mentioned in the First Schedule to the Order may, up to and including August 31st, 1941, be acquired without licence by (and disposed of accordingly to) any Government Department, undertaking, or person mentioned in head (*a*) or (*b*) of Paragraph 4 of the Control of Iron and Steel (No. 8) Order, 1940, Direction No. 1,[8] for the purpose which was prescribed in that head in respect of that Government Department, undertaking, or person, and may be treated, used, and consumed for that purpose.

Provided that nothing in this paragraph shall authorise a stockholding merchant to acquire any iron, except iron (not being pig iron) delivered directly from the supplier of the stockholding merchant to a customer of the stockholding merchant.

2. This Direction shall come into force on July 17th, 1941, and may be cited as the Control of Iron and Steel (No. 15) Order, 1941, Direction No. 1.

Dated this 12th day of July, 1941.

R. D. FENNELLY,
A Principal Assistant Secretary
in the Ministry of Supply.

Artificial Abrasives and Nitrogen in the United States

PRODUCTION of artificial abrasives in the U.S.A. can be increased about 50 per cent. over the output of 1940 without building new plants, according to data recently assembled by the Bureau of Mines, United States Department of the Interior. By overhauling production schedules, reports from abrasives manufacturers indicate maximum production of artificial abrasives could be increased to 152 per cent. of the 1940 output, and the nature of the industry is such that plant capacity could be expanded rapidly. With the exception of industrial diamonds, according to the data gathered by the Bureau, the United States could attain self-sufficiency in regard to all necessary abrasives, even with a complete stoppage of seaborne traffic.

Imports of artificial abrasives have been large, greatly exceeding domestic production, but have come chiefly from Canada. As the manufacture of crude abrasive material is relatively simple, being conducted in arc or resistance type furnaces, which are partly dismantled after each charge, production of the crude materials now carried on largely in Canada could be transplanted to any of the hydro-electric power developments in the United States without prohibitive capital outlay or time lag. Raw materials and supplies for producing artificial abrasives are available in ample quantities in the country. Even bauxite used in making fused alumina is mainly produced domestically, although that used in making aluminium is largely imported. Certain manufacturers of fused alumina own bauxite deposits and are thus assured of an adequate supply of this essential raw material. In the production of certain natural abrasives the United States does not occupy the position of self-sufficiency exhibited with regard to the artificial or manufactured varieties. Not only industrial diamonds, but also corundum ore, certain kinds of pumice, tube mill linings and pebbles and special razor hones, have been largely imported, so that actual or prospective curtailment of imports may impose certain hardships and readjustments. Only three of the abrasive materials regularly imported have come from the Axis Powers or countries that have fallen into their hands, and it is fortunate that domestic materials may be substituted for these items. Industrial diamonds are the only abrasives that might eventually be listed as a strategic material as defined by the Army and Navy Munitions Board. Except for limited production in Arkansas and sporadic finds in the glacial drifts of Wisconsin and other States, diamonds have not been produced in this country ; and the United States, with other industrial nations of the world, must look mainly to Africa for its supplies. Plant capacity to manufacture both coated abrasives and grinding wheels, according to the Bureau's survey, appears to be ample or capable of ready expansion. Annual production

[8] Printed at the end of S.R. & O., 1940, No. 496.

of grinding wheels in the United States is valued at more than 20,000,000 dollars. With ample supplies of abrasive materials and bonding agents—the latter are also abundantly available in this country—the only conceivable bottle-neck in grinding wheel manufacture would be the capacity of currently existing kilns or firing plants. A recent survey of plant capacity made by the producers of abrasive grain and grinding wheels indicates that no bottle-necks are liable to develop in the grinding wheel manufacturing industry.

Potential capacity in the United States for the production of nitrogen, a principal constituent of explosives and fertilisers, will soon reach 800,000 short tons a year, as compared with a production of 424,000 tons in 1939, according to estimates contained in a report submitted by Dr. R. R. Sayers, Director of the Bureau of Mines, to the Secretary of the Interior, Harold L. Ickes. Of the chemical nitrogen used in that country, according to the report, nearly one-half now is produced synthetically from the nitrogen of the air, about one-third is imported and the remainder is obtained as a by-product of the manufacture of coke. Well over half of the imports of chemical nitrogen in the United States in former years have come from Chile in the form of sodium nitrate, but owing to the cessation of such imports from Europe the proportion imported from Chile has jumped to about three-fourths. The bulk of the remaining nitrogen imports into the United States come from Canada in the form of calcium cyanamide. The report shows that production of fixed nitrogen (from the air) in the United States for 1939 was 280,000 tons, but by substantial modernisation or alteration of existing equipment capacity could be substantially increased to about 410,000 tons a year with the new plant construction. Three synthetic ammonia plants (including the rehabilitation of United States nitrate plant No. 2 at Muscle Shoals) are under construction. On completion of this programme of expansion the combined production capacity of synthetic chemical nitrogen plants will be about 600,000 tons a year. The production of by-product chemical nitrogen ordinarily depends largely on the manufacture of coke, which in turn depends largely on the output of iron and steel. Because of substantial additions being made to the capacities of by-product coke oven plants, maximum capacity for production of by-product nitrogen very likely will be about 190,000 tons annually. Total potential domestic capacity for both synthetic and by-product nitrogen, therefore, will soon approach, the Bureau estimates, double the output of 424,000 tons in 1939. Ordinarily almost three-fourths of the total domestic consumption of chemical nitrogen is in fertilisers, the remainder being used in industry and for the manufacture of explosives. The increased use of chemical nitrogen in the manufacture of explosives is expected, however, to alter these proportions to some degree.

TECHNICAL REPORTS

E.R.A. Report, Ref. G/T 131 : *Recent Experience with Calcium Sulphate and other Types of Cement for Glass Inserts in Flameproof Enclosures.* By A. P. Paton, B.Sc., A.M.I. Mech. E.—Since the issue of report Ref. G/T 114 in September, 1939 (dealing with information available at that time on calcium sulphate and iron cements), certain new calcium sulphate products have been produced. A questionnaire was sent to firms likely to be interested in the use of these cements for flameproof gear, and the present report embodies the information received. Some new information is included on litharge and glycerine cements and iron cement, and general questions relating to hydration of calcium sulphate cements are also dealt with. Copies may be obtained from the British Electrical and Allied Industries Research Association, 15, Savoy Street, London, W.C.2. Price 1s. 6d., postage 4d.

THE BURMA AND CHINA RAILWAY.—The question of railway communication between Burma and China has been under discussion for many years. It was, in fact, first examined in the 'nineties. Some three years ago the construction of the whole line, both in Burma and China, was under consideration by private commercial organisations, but this came to nothing, as it was doubted whether the line would become a paying proposition from the point of view of private investors. Similar considerations precluded the Government of Burma from undertaking the project from their own resources, but it has now been decided that as a long-term project the railway will be constructed from funds provided by H.M. Government in the United Kingdom, the Government of Burma to be given the option to acquire the railway at a later date. The railway will follow a different alignment from the famous Burma Road for about two-thirds of its length, thereafter following much the same route as the Road to Kunming. The length to be built in Burma is 110 miles across the hilly plateau of the Federated Shan States. In Burma the first half is comparatively straightforward, but the second half will involve many cuttings and bridges. The chief task in the Burma section is the bridging of the Salween, a river 500ft. wide. The first section in China is comparatively simple, running up the Namting Valley; thereafter comes a very difficult section in which immense ranges of hills, 7000ft. in height with precipitous sides, have to be crossed, including a major bridge over the Mekong River. The eastern half of the Chinese section is easier; on this part a good deal of work has already been done. It is estimated that the Burma section will cost not less than £2,000,000, and will take about two years to complete.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Control of Iron Products

The Ministry of Supply has issued the Control of Iron and Steel (No. 15) Order, 1941—see page 60—which came into force on July 17th, 1941, and revokes the Nos. 8, 10, 11, 12, and 13 Orders. The principal alterations under the Order are :—(1) The incorporation in the Distribution of Steel Supplies Scheme of all iron products, except pig iron, but including iron castings, with effect as from September 1st next. It will be necessary for all then existing orders to have been authorised by the responsible Government Departments at that date. For the period to August 31st next the Direction No. 1 issued with the Order maintains the present arrangements for licensing of iron products. (2) The prohibition of the treatment, use, and consumption without authority of iron and steel in the production, repair, or maintenance of articles not controlled under the Order. The main effect of the new provision will be to control the use of iron or steel by firms within the industry who also make products not subject to control, *e.g.*, an ironfounder cannot convert his iron castings into stoves or baths without authority. (3) The quantity and value of material which may be bought by any one customer from stockholding merchants without licence is limited. This supplements the arrangements already in force by which the quantities allocated to stockholders are rationed. In addition, the control is extended to cover iron powder, carbon graphite electrodes, and anodes, except illuminating and welding qualities, and petroleum coke. The acquisition of all iron powder, except carbonyl iron powder, has been exempted from licence. Apart from the exemption from licence of small purchases from stockholding merchants, as mentioned above, provision is made for the exemption of small purchases of certain materials, whether purchased from a stockholding merchant or a producer. The maximum prices fixed under the Order are, in the main, unaltered, but minor adjustments and additions have been made in the schedules. Copies of the Order, including Direction No. 1, may be obtained from H.M. Stationery Office, York House, Kingsway, W.C.2, or through any bookseller, on and after July 19th, 1941.

The Pig Iron Market

The activity which characterised the pig iron market a week or two ago has diminished, since most of the allocations received by the consumers from the Control have now been covered. There are still, however, some contracts under negotiation. The demand for high phosphoric pig iron remains comparatively quiet, since the light castings industries, both in England and Scotland, are by no means fully employed, as a result of the restrictions upon building. A few of the light castings foundries have secured work from the Government, but hopes which were entertained that the industry might be fully employed upon war work have not been fulfilled, as in many cases the establishments were not suitable for these requirements. The heavy engineering foundries, however, are busily employed, and are taking up large quantities of hematite and special irons, and in some cases are making use of a certain amount of high phosphoric iron, which they are using to substitute for other qualities. There has been a rather better demand in Lancashire for some of the lower qualities of pig iron, but employment in the jobbing foundry trade has fluctuated of late, and a number of firms cannot see their way far ahead. The makers of high phosphoric iron in the Midlands are experiencing a strong demand, and are supplying most of the foundries on the North-East Coast, whilst they are also sending good quantities to Scotland. Business in low phosphoric iron and hematite is restricted, although the demand continues heavy and wherever possible consumers are using substitutes in order that these descriptions should be reserved for special work. The demand for foundry pig iron in Scotland is steady, but sufficient supplies are available to meet all requirements. The heavy engineering foundries are extremely busy, and are using considerable quantities of special irons.

Scotland and the North

The busy conditions which have ruled at the Scottish steel works for so long are well maintained, and large tonnages of steel of all descriptions are being produced for the Government. In certain directions the works appear able to give more prompt delivery than for a long time, but, on the other hand, the requirements of the Services and Government Departments are so large that only a small proportion of the output can be devoted to non-essential uses or to the export trade. The demand for plates is one of the features of the position. This has existed for some months now, and so far as can be seen will continue for a long time, since the shipyards are fully employed upon new construction and repairs. The position of structural steel does not change greatly, and whilst the heavier sizes are not in quite such active request, there is a steady call for the lighter sizes, and the pressure to obtain deliveries is unchecked. There is also an insistent demand for alloy and special steels, which are required in large quantities by the armament and munition makers. The Scottish wrought iron makers have good order books, principally for best quality iron, but the commoner sorts are not in particularly strong request. The sheet works are fully employed, but the amount of new business coming forward has shown some decline, and the works for the most part are able to give quicker deliveries than has been the case for some months. In the Lancashire market a huge volume of business has been transacted of late, and there has been a greatly increased request for special materials, including nickel and alloy steels, stainless, and heat-resisting steels. Steel bars have an active market, and there is steady pressure to obtain supplies of the large as well as the small diameters. On the North-West Coast the steel works are actively engaged upon work arising from the war and are turning out large tonnages of steels.

The North-East Coast and Yorkshire

The whole of the steel industry on the North-East Coast is busily employed upon Government requirements arising out of the war. A few complaints are heard that steel materials for ordinary business are practically impossible to obtain, except in special cases, but it is realised that this is a state of affairs that cannot be avoided. The works employed upon producing semis are operating at heavy pressure, and the demand for these products seems likely to increase, as a result of the restriction upon imports. The re-rolling works, however, are not likely to suffer, since the Control has the situation well in hand, and is understood to have large reserves to meet any extra calls which may be made upon it. There is a steady demand for joists and heavy sections, and lately the requirements have increased for this class of material, although the demand is not so strong as for the lighter sections which are passing into consumption almost as soon as they are produced. There is a strong request for special steels, and the demand for these looks like expanding still further. For the time being the position is rather tight in spite of considerable imports from the United States. The call for plates continues insistent, and big tonnages are being produced. The shipbuilding industry is taking large quantities, and will continue to do so for a long time, since the industry has a particularly heavy programme of work in hand. The boilermakers are fully occupied, and the tank makers also are requiring plates of all thicknesses. All the steel works in the Yorkshire district are fully employed, but reports are current that there is a slackening in the demand for supplies from several quarters. The home demand for billets has increased, but the production is on a good scale, and supplies reach consumers regularly. For the moment there would appear to be a particularly strong demand for shell and tank steels, and some works are concentrating upon these descriptions. There is, of course, a never-ceasing call for aircraft steels. At Sheffield there is great activity, and amongst the busiest section of the trade is the crucible steel industry.

Copper and Tin

The copper situation does not change much from week to week. In Great Britain consumers are receiving the full supplies with regularity and so far as is known shipments continue to reach here in sufficient volume to make the position secure. There is a huge demand and, naturally, the Control carefully scrutinises applications for licences in order to ensure that the metal is not used for unessential purposes. In the United States the position seems rather tight, but prices are unchanged at 12c. for domestic and 11c. f.a.s. for export, but the latter quotation is purely nominal, since no copper is available for overseas destinations. The American defence programme is absorbing huge quantities, and since licences have been instituted in the United States the position there much resembles that existing in Great Britain. A certain amount of nervousness is shown by the American copper trade as to whether future supplies will be sufficient to meet the requirements of ordinary commercial users as well as the defence programme and the "aid to Britain" plans. The United States can, however, obtain large supplies from South American mines, although it is suggested that the quantities hitherto obtained have not come forward so quickly or reliably as had been expected. There seems little doubt, however, that it would be only a question of time until satisfactory arrangements are made to deal with the situation. . . . The tin market has fluctuated within narrow limits and so far as can be judged there is not likely to be any sharp change for the time being. No export licences are being issued to any destination and apparently the authorities are attempting to accumulate stocks. There have been some export inquiries, which, under these conditions, have not matured into business. British consumers are receiving supplies for war work and in this respect the situation is comfortable. The present price of tin should be satisfactory to producers, and although the world production is probably for the time being in excess of the world's consumption, there seems no likelihood of an important downward movement. There is, of course, practically no speculation in the market, which in its present state is not likely to attract speculators.

Lead and Spelter

The lead position in Great Britain remains comfortable and although the demand from the war industries is on a heavy scale the position is satisfactory. A certain amount of lead is also available for commercial purposes, but by far the greater proportion of the demand is for uses arising from the war. One of the most active branches of the consuming industries is the cable and battery makers and, on the other hand, the call for lead pipes and sheets is on a rather disappointing scale. In the United States there is a big demand largely on account of the defence programme. Civilian consumption has already been decreased in the United States, and although stocks of lead are at a low level in that country the position does not seem to cause serious concern. The situation, however, does appear to be growing tighter. . . . Rather stringent conditions rule in the spelter market, although so far as the war industries are concerned the consumers are obtaining all the metal they require. There have been some export inquiries, but these have rarely been satisfied. India has been in the market for hard spelter, and it is suggested that consumers in that country have also applied for metal to Canada. In the United States the position remains practically unchanged and is as stringent as it has been during the past month or two. Prices have remained unchanged at 7½c., East St. Louis, for the domestic market.

PROFESSOR C. O. BANNISTER is retiring from the Chair of Metallurgy, Liverpool University, which he has held since its foundation in 1920.

Notes and Memoranda

Rail and Road

AN INDUSTRIAL LINE.—Reports from Russia indicate the opening of a railway from Neldy to Jezkazgan. This 260-mile line connects the Jezhazgan copper-producing area with the main railway system of the U.S.S.R., and is likely to play an important part in the economic development of the area traversed.

PRODUCER GAS VEHICLES.—Vauxhall Motors, Ltd., of Luton, has entered the producer gas field, with a cross-draught product with an ash-discharging floor plate below the fire, and also an inlet manifold for petrol-started producer gas vehicles, the object of which is to provide passages of cross-sectional area appropriate to the requirements of the two fuels.

PRODUCER GAS VEHICLES IN FINLAND.—A year ago so little petrol was available in Finland that lorry owners could obtain a limited supply only if they could show that arrangements had been made to install wood or charcoal-burning gas producers. As a consequence by the end of 1940 there were about 8500 producer gas vehicles in traffic.

EMPLOYMENT ON BRITISH RAILWAYS.—The total wages bill of the British railway staffs in 1940 is said to have been £123,000,000. The total number employed was 555,337, including the following main grades:—67,000 clerks, 35,000 drivers and motormen, 33,000 firemen, 50,000 permanent way men, 40,000 porters, 17,000 shunters, 23,000 signalmen, and 106,000 employed in the shops.

ARGENTINE FUEL SHORTAGE.—The Argentine railways are feeling the pinch of fuel shortage. The usual supply of British coal is now practically cut off. American coal is largely unobtainable owing to exchange problems. Wood fuel is used, but its bulk and low calorific value make it unsatisfactory even for goods train working. Fuel oil, difficult to obtain, involves the conversion of locomotives, and the executives are turning to the surplus of maize in the country. Efforts are being made to find a suitable way of burning it—alone or mixed with coal—in locomotive fire-boxes.

"NO SMOKING."—The New York suburban passenger railways are getting worried over the smoking problem, and new indicators for smoking and non-smoking carriages were installed recently by one company in all its 1300 steam and electric passenger carriages. Fitted to brackets on both ends of each carriage, the new signs have a green background with white letters reading "Smoking Permitted" on one side, and a red background with "Smoking Prohibited in This Car" on the reverse. Since February this company has pursued a uniform policy of placing smoking carriages at the east end of all trains. Formerly it placed smoking carriages next to locomotives on steam trains and at the east end of electric trains.

SALVAGE OUT OF THE ORDINARY.—Last winter an Allis-Chalmers tractor of 3 tons weight was creeping across an ice-bound sound in Canada when a crack developed and the tractor and its trailer sank in 100ft. of water some 3 miles from the shore. *Canadian Engineering* has since disclosed how it was retrieved after being located by a diver. A number of big boom timbers, some 60ft. in length, were hauled to the scene of the accident and a huge raft built. A headframe was constructed above the raft, the complete structure being made strong enough to float the tractor. The work, after all was made ready, took three days and entailed six dives by two men. The only damage to the tractor was to the fuel tank. It was only half full when the machine sank, and the pressure of the water flattened it.

THE WELSH HIGHLAND RAILWAY.—The Welsh Highland Railway has been purchased for dismantling by George Cohen, Sons and Co., Ltd. As a consequence, some 1200 tons of relayable rails, several thousand sleepers, and a considerable tonnage of scrap will become available for the national war effort. The railway runs for about 28 miles from Portmadoc to Dinas Junction, in Caernarvonshire. It has not paid for many years past, although there was at one time a fair traffic in timber, as well as in slate from the neighbouring quarries. It was originally called the North Wales Narrow Gauge Railway, and was opened in 1875 from Dinas Junction to South Snowdon. In 1923 the name was changed to the Welsh Highland, and an extension built to Portmadoc, joining up with the Festiniog Railway of the same gauge. In 1934 the line was leased to the Festiniog and three years later it was closed to all traffic by that company. There are two locomotives, a Russell 2–6–2 tank, built in 1906 at Hunslet Foundry, and a Baldwin 4–6–0 tank, built at the Baldwin Locomotive Works, U.S.A., in 1917.

Air and Water

MOTOR LIFEBOAT FOR CARMARTHEN.—A motor lifeboat has arrived at Ferryside, Carmarthen Bay, to replace the pulling and sailing lifeboat. It has been stated that there is now only one lifeboat on the Welsh coast which is not motor driven.

CANADIAN AIR SERVICES.—The services of Canadian Airways, Ltd., and Mackenzie Air Service, Ltd., have now been taken over by the Canadian Pacific Railway. The two companies will in future operate under the name of United Air Services, Ltd.

GOLDEN GATE BRIDGE.—Tests made recently on a model of the Golden Gate bridge in the wind tunnel at Stanford University were referred to in a recent report by Mr. Russell G. Cone, the district's former engineer. Mr. Cone recommends further studies because he believes the recent model tests at Stanford were not conclusive. Aerodynamic forces were not taken into account at the time the Golden Gate bridge was designed, and Mr. Cone suggests that it is advisable to make a thorough investigation in the light of the new knowledge gained as a result of the Tacoma Narrows bridge collapse. Professor E. G. Reid, who made the wind tunnel tests, has expressed the opinion that they did not indicate any dangerous vibrations characteristic in the bridge. The Golden Gate bridge withstood a wind velocity of 72 m.p.h. some years ago with only relatively slight deflection.

AMERICAN AIRCRAFT PRODUCTION.—Military and heavy commercial aircraft produced in the United States during the month of June numbered 1476. This exceeds the total for April, which was the next highest, by forty-nine. Lowest for the first six months of the year was February, with 972. The monthly production over the first half of this year averages 1223.

MERCANTILE SHIPPING LOSSES IN JUNE: ERRATUM.—With reference to the June shipping losses, referred to in one of last week's Journal notes, we pointed out that the June losses were substantially lower than those for May, but that it was still necessary to reduce still further the high rate of sinking. The figure of 400,000,000 tons yearly should, of course, have read 4,000,000 tons.

CONSOLIDATED B-24 LIBERATORS.—An announcement in *Flight* records that the Ford Motor Company is to build complete Consolidated B-24 Liberators at a new plant now being constructed at Ypsilanti, Michigan. The factory was designed originally as a parts factory, but provision was made for the easy addition of a very long assembly line. Parts and perhaps complete engines will be turned out by the end of the year, it is reported. It is stated that the plant is being designed to produce 270 bombers per month.

EIRE AND U.S.A. AIR SERVICE.—It has been announced that a direct air service has been established between Eire and the United States. British Overseas Airways propose to maintain this service between Foynes and Baltimore with the flying boats "Bristol," "Bangor," and "Berwick." The new route is to be additional to the service already in operation from this country *viâ* Lisbon, and the air ferry service.

Miscellanea

LITHARGE FOR RUBBER.—Time was when the lead oxide known as litharge was widely used in the rubber industry. Then zinc oxide took its place, but with a war shortage makers of certain grades of rubber are replacing zinc oxide in many cases by means of litharge. The fact that the latter blackens during vulcanisation, and can therefore only be used in dark products, limits its application.

LUBRICATING THE WAR MACHINE.—The Aziende Nazionale Industrie Combustibile, Italy's largest oil and coal hydrogenation undertaking, will begin the production of synthetic lubricating oil and paraffin this year. War conditions have given a pronounced impetus to the Mexican graphite industry, exports to the U.S.A. having advanced from 18·1 to 29·1 million pounds between 1939 and 1940.

CANADIAN PETROLEUM.—Canada's output of crude petroleum is steadily rising. In 1940 it totalled 8,718,000 barrels, as compared with 7,837,500 barrels in 1939. Last year's output set up a new record for the fourth year in succession. In 1936 production was only 1,500,400 barrels. The introduction of the acidisation process in 1937 was an influential factor in bringing about the increased production, but many new wells have been put into operation, during the last three years.

THE I.E.E.'s NEW FIELD.—What is to be known as the Installations Section of the Institution of Electrical Engineers will have within its scope "all matters relating to the study, design, manufacture, construction, installation, maintenance, operation, and employment of equipment and apparatus used in electrical installations inside and outside buildings, including those for lighting, heating, ventilating, and domestic purposes, and for general industrial, agricultural, mining, and marine applications."

TIN FOR GLASSMAKERS.—Increasing attention is being paid to the use of tin oxide in glass making. It is employed to impart a degree of opacity to shades for lamps and is widely used in the opal glass backing of tubing intended for thermometers, burettes, levels, and gauge glasses. Stannous chloride is used in the production of ruby glasses, while stannic oxide, otherwise "putty powder," is a recognised abrasive for polishing the rough surface of cuts produced by carborundum wheels in the manufacture of cut table glass. The "putty powder," suspended in water, is fed on to the edge of a wooden polishing wheel shaped to the angle of the cut.

NO AFTER GLOW.—The sale of matches that have an "after glow" is prohibited in most of the States of America, and makers are devising methods of preventing a spark on the splint after striking. For wooden matches an effective and widely used treatment consists in dipping the splints to about two-thirds of their length in a weak aqueous solution (about 0·5 per cent.) of ammonium phosphate, and then driving off the surplus water from the wood by treatment in a drying chamber. Board for book match use is usually impregnated at the paper mill during the manufacturing process, thereby requiring no further impregnation treatment at the match factory.

BRICK INDUSTRY COMMITTEE.—The Minister of Works, in view of the importance of an efficient brick industry both during and after the war, has decided, with the agreement of the industry, to appoint a committee, representative of all interests, to advise him on the subject. Mr. Oliver Simmonds, M.P., has agreed to be Chairman of the Committee, which will, in particular, advise on steps to be taken to secure adequate output, maximum co-ordination, pooling of resources, and information, economy of manufacture and introduction of more scientific methods. The Committee will first consider steps to be taken immediately to assist the war effort.

THE COST OF GAS MASKS.—The U.S.A. will spend 10 million dollars in connection with supplies of gas mask charcoal and other chemicals used in gas defensive appliances. The figures come from the Chemical Warfare Service of the United States Army. About half of this total is to cover the cost of construction of certain plants which will be owned by the Government, though built by the firms concerned.

FROM MILK TO PARAFFIN.—The Alfa-Laval Company, Ltd., has adapted its dairy machines for cleaning machine parts, aircraft components, and engineering plant generally by means of a paraffin wash. The parts to be cleaned are placed in a welded spray booth on a loose perforated plate, and the washing is effected by means of a pistol type spray gun with trigger-operated control valve and an adjustable nozzle. The used paraffin gravitates to a tank and after being strained and clarified is used again. The complete unit is self-contained, 6ft. high by 6ft. wide, and weighs approximately 10 cwt.

THE IMPORTANCE OF PEBBLES.—War has interrupted the supplies of grinding pebbles from Denmark, Belgium and France, and the U.S. Bureau of Mines has had to investigate domestic sources. The feldspar industry is one of the largest users of flint grinding mediums, and they are also used by grinders of talc, soapstone, sandstone, quartz, chalk, lithopone and other materials. Flint pebbles have been used largely in cement mills and for the fine grinding of gold, copper and other ores in which iron contamination is not specially deleterious. Quartzite deposits near Jasper, Minnesota, appear to be the only American source of grinding pebbles.

Personal and Business

CAPTAIN J. MONTADOR, marine superintendent of T. and J. Brocklebank, Ltd., Liverpool, has retired.

MR. E. O. TAYLOR has been appointed to the senior lectureship in electrical engineering at the Heriot-Watt College, Edinburgh.

MR. H. M. WOODHAMS, general manager of Sir W. G. Armstrong, Whitworth Aircraft, Ltd., has been appointed to the board of directors.

MR. N. A. MATHESON has been appointed harbour engineer at Dundee, in succession to Mr. J. Hannay Thompson, who is retiring.

MR. W. JORDAN ADAM has been appointed a member of the Chemistry Research Board of the Department of Scientific and Industrial Research.

MR. B. ELIOT COMMON has been appointed Regional Port Director for the North-Eastern Region of England, which extends from the Tweed to the Tees.

MAJOR EDMUND HOWARD has been appointed Controller of Building Construction in the Ministry of Supply, in place of Mr. J. W. Gibson who has resigned.

CAPTAIN J. B. BLACK, of Standard Motors Company, Ltd., has been appointed Chairman of the Joint Aero-Engine Shadow Committee of the Ministry of Aircraft Production.

THE CARBORUNDUM COMPANY, Ltd., informs us that the address of its London office is now 3 and 4, Parkfield Parade, High Road, Ickenham, Middlesex. Telephone, Ruislip 3586.

MR. GEOFFREY DAWSON is retiring from the editorship of *The Times* in September. He will be succeeded by Mr. R. M. Barrington-Ward, who has been assistant editor for nearly fourteen years.

MR. F. G. BRISTOW, general secretary of the Commercial Motor Users Association, has been elected Chairman of the National Executive Committee of the Royal Society for the Prevention of Accidents.

THE headquarters of the Ministry of Labour and National Service are now at St. James's Square, London, S.W.1. The telephone number is Whitehall 6200, and the telegraphic address "Minlabour, Piccy, London."

THE Minister of Supply has appointed Sir James Calder, Adviser on Home Timber Production, to the Raw Materials Branch of the Ministry. Mr. G. Lenanton has succeeded Sir James as Director of Home Timber Production.

MR. ASHLEY S. WARD has been appointed chairman and managing director of Thos. W. Ward, Ltd. Mr. George Wood has been appointed deputy chairman and joint managing director, and Mr. Arnold Carr has been appointed a full director of the company. Mr. Ashley S. Ward has also been appointed chairman of the Ketton Portland Cement Company, Ltd., and Mr. F. R. Stagg deputy chairman and managing director of that company. Mr. Stagg is also assistant managing director of Thos. W. Ward, Ltd.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Diesel Engine Users Association

Wednesday, July 30th.—Caxton Hall, Caxton Street, S.W.1. Heavy Oil Engine Working Costs Report, 1939–40 2.30 p.m.

Iron and Steel Institute

Saturday, July 26th.—Technical College, Newport, Mon. Joint meeting with Newport Metallurgical Society. "The Influence of Some Special Elements upon the Strain-ageing and Yield Point Characteristics of Low-carbon Steels," C. A. Edwards. 6.15 p.m.

Physical Society

To-day, July 25th.—Science Museum, South Kensington, S.W.7. Charles Chree Address, by Professor S. Chapman. 5 p.m.